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DJANGO

—— *for* ——

PROFESSIONALS

Production websites with Python & Django

WILLIAM S. VINCENT

Django for Professionals

Production websites with Python & Django

William S. Vincent

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Also By **William S. Vincent**

[Django for Beginners](#)

[Django for APIs](#)

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Introduction

Welcome to *Django for Professionals*, a guide to building professional websites with the [Django](#), a Python-based web framework. There is a massive gulf between building simple “toy apps” that can be created and deployed quickly and what it takes to build a “production-ready” web application suitable for deployment to thousands or even millions of users. This book will show you how to bridge that gap on both Windows and macOS computers.

When you first install Django and create a new project the default settings are geared towards local development. And this makes sense: there’s no need to add all the additional features required of a large website until you know you need them. These defaults include the use of SQLite as the default database, a local web server, local static asset hosting, built-in User model, DEBUG mode turned on, and many other settings that are implicitly set.

For a production project many, if not most, of these settings must be reconfigured. And even then there can be a frustrating lack of agreement among the experts. Rather than overwhelm the reader with the full array of choices available this book shows one approach for building a professional website grounded in current Django community best practices. The topics covered include using Docker for local development and deployment, PostgreSQL, a custom user model, robust user authentication flow with email, comprehensive testing, environment variables, security and performance improvements, and more.

By the end of this book you will have built a professional website step-by-step and learned about additional areas for further exploration. Whether you are starting a new project that hopes to be as large as Instagram (currently the largest Django website in the world) or making much-needed updates to an existing Django project, you will have the tools and knowledge to do so.

Prerequisites

If you’re brand-new to either Django or web development, this is not the book for you. The pace will be far too fast. While you *could* read along, copy all the code, and have a working website

at the end, I instead recommend starting with my book [Django for Beginners](#). It starts with the very basics and progressively introduces concepts via building five increasingly complex Django applications. After completing that book you will be ready for success with this book.

I have also written a book on transforming Django websites into web APIs called [Django for APIs](#). In practice most Django developers work in teams with other developers and focus on back-end APIs, not full-stack web applications that require dedicated JavaScript front-ends. Reading *Django for APIs* is therefore helpful to your education as a Django developer, but not required before reading this book.

We will use Docker throughout most of this book but still rely, briefly, on having Python and Django installed locally. Git and the command line are also necessary components of the modern developers toolchain and will both be used extensively in this book as well.

Book Structure

Chapter 1 starts with setting up your local computer for development by using the command line, installing Python, configuring Git, and creating virtual environments. *Chapter 2* is an introduction to Docker and explores how to “Dockerize” a traditional Django project. In *Chapter 3* PostgreSQL is introduced, a production-ready database that we can run locally within our Docker environment and also deploy to production. Then *Chapter 4* starts the main project in the book: an online Bookstore featuring a custom user model, search, image uploads, permissions, and a host of other goodies.

Chapter 5 focuses on building out a Pages app for a basic homepage along with robust testing which is included with every new feature on the site. In *Chapter 6* a complete user registration flow is implemented from scratch using the built-in auth app for sign up, log in, and log out. *Chapter 7* introduces proper static asset configuration for CSS, JavaScript, and images as well as the addition of Bootstrap for styling.

In *Chapter 8* the focus shifts to advanced user registration, namely including email-only log in and social authentication via the third-party `django-allauth` package. *Chapter 9* introduces environment variables, a key component of Twelve-Factor App development and a best practice widely used in the web development community. Rounding out the set up of our project, *Chapter 10* focuses on email and adding a dedicated third-party provider.

The structure of the first half of the book is intentional. When it comes time to build your own Django projects, chances are you will be repeating many of the same steps from Chapters 3-9. After all, every new project needs proper configuration, user authentication, and environment variables. So treat these chapters as your detailed explanation and guide. The second half of the book focuses on specific features related to our Bookstore website.

Chapter 11 starts with building out the models, tests, and pages for our Bookstore via a Books app. There is also a discussion of URLs and switching from `id` to a slug to a UUID (Universally Unique Identifier) in the URLs. *Chapter 12* features the addition of reviews to our Bookstore and a discussion of foreign keys.

In *Chapter 13* image-uploading is added and in *Chapter 14* permissions are set across the site to lock it down. For any site but especially e-commerce, search is a vital component and *Chapter 15* walks through building a form and increasingly complex search filters for the site.

In *Chapter 16* the focus switches to performance optimizations including the addition of `django-debug-toolbar` to inspect queries and templates, database indexes, front-end assets, and multiple built-in caching options. *Chapter 17* covers security in Django, both the built-in options as well as additional configurations that can-and should-be added for a production environment. The final section, *Chapter 18*, is on deployment, the standard upgrades needed to migrate away from the Django web server, local static file handling, and configuring `ALLOWED_HOSTS`.

The *Conclusion* touches upon various next steps to take with the project and additional Django best practices.

Book Layout

There are many code examples in this book, which are formatted as follows:

Code

```
# This is Python code
print("Hello, World!")
```

For brevity we will use three dots, `...`, to denote existing code that remains unchanged in a longer code example. For example, in the function below, the previous content is unchanged

and the `print()` statement has been added. In these cases there will also be a comment, `# new`, indicating where the new code has been added.

Code

```
def make_my_website:
    ...
    print("All done!") # new
```

Complete source code for the book can be found in the [official Github repository](#). It is a good place to check first if there are any issues with your code.

Community

“Come for the framework, stay for the community” is a common saying among Django developers. While the Django code base is very impressive, ultimately the health of the project up to this point and going forward depends upon the community that has grown around it. Django development happens publicly on the [django-developers](#) list and the project is overseen by a non-profit, the [Django Software Foundation](#), which manages contributions, supports annual DjangoCon conferences, and local meetups where developers gather to share knowledge and insights. There is an official [Django forum](#) populated by many members of the community which is an ideal place to ask for help.

No matter what your level of technical expertise becoming involved in Django itself is a great way to learn, to meet other developers, and to enhance your own reputation.

Conclusion

Django is an excellent choice for any developer who wants to build modern, robust web applications with a minimal amount of code. In the next chapter we'll make sure your computer is properly set up for web development before diving deeply into Django itself in the rest of the book.

Chapter 1: Initial Set Up

This chapter covers how to properly configure your Windows or macOS computer to work on Django projects. It is similar to the set up guides in both *Django for Beginners* and *Django for APIs* so if you are already familiar with the command line, have the latest version of Python installed, know how to create virtual environments, and use Git you can consider this chapter optional. Otherwise read through to make sure your computer is ready for professional Django development and success in the rest of this book.

The Command Line

The command line is a text-only interface that is used frequently by developers. It harkens back to the early days of computer interfaces before the mouse and graphical user interfaces became the norm. In practice, multiple terms are used to refer to the command line: Command Line Interface (CLI), console, terminal, shell, or prompt. Technically speaking, the *terminal* is the program that opens up a new window to access the command line, a *console* is a text-based application, the *shell* is the program that runs commands on the underlying operating system, and the *prompt* is where commands are typed and run. It is easy to be confused by these terms initially but they all essentially mean the same thing: the command line is where we run and execute text-only commands on our computer.

On Windows, the built-in terminal and shell are both called *PowerShell*. To access it, locate the taskbar on the bottom of the screen next to the Windows button and type in “powershell” to launch the app. It will open a new window with a dark blue background and a blinking cursor after the > prompt. Here is how it looks on my computer.

Shell

```
PS C:\Users\wsv>
```

On macOS, the built-in terminal is called appropriately enough *Terminal*. It can be opened via Spotlight: press the **Command** and **space bar** keys at the same time and then type in “terminal.” Alternatively, open a new Finder window, navigate to the *Applications* directory, scroll down to open the *Utilities* directory, and double-click the application called *Terminal*. This opens a new screen with a white background by default and a blinking cursor after the `%` prompt. Don’t worry about what comes to the *left* of the `%` prompt. It varies by computer and can be customized later on.

Shell

```
Wills-Macbook-Pro:~ wsv%
```

To avoid confusion around the different prompts for each operating system—> on Windows and `%` on macOS—in this book we will use the Unix prompt of `$` for any command line usage. Where there is a difference between Windows and macOS both commands will be listed.

There are many available shell commands but most developers rely on the same handful over and over again and look up more complicated ones as needed. In most cases, the commands for Windows (PowerShell) and macOS are similar. For example, the command `whoami` returns the computer name/username on Windows and just the username on macOS. As with all shell commands, type the command itself followed by the **return** key. Note that the `#` symbol represents a comment and will not be executed on the command line.

Shell

```
# Windows
$ whoami
wsv2022/wsv
```

```
# macOS
$ whoami
wsv
```

Sometimes, however, the shell commands on Windows and macOS are completely different. A good example is the command for outputting a basic “Hello, World!” message to the console. On Windows the command is `Write-Host` while on macOS the command is `echo`.

Shell

```
# Windows
$ Write-Host "Hello, World!"
Hello, World!
```

```
# macOS
$ echo "Hello, World!"
Hello, World!
```

Most Django developers are not command line experts and rely on the same handful of commands over and over again. In this book I will provide the exact instructions to run each time but if you are curious, a complete list of shell commands for each operating system can be found over at ss64.com.

Install Python 3

Make sure that the latest version of Python (3.10 as of this writing) is available on your computer. On Windows, Microsoft hosts a community release of Python 3 in the Microsoft Store. In the search bar on the bottom of your screen type in “python” and click on the best match result. This will automatically launch Python 3.10 on the Microsoft Store. Click on the blue “Get” button to download it.

To confirm Python was installed correctly, open a new Terminal window with PowerShell and then type `python --version`.

Shell

```
$ python --version
Python 3.10.4
```

The result should be at least Python 3.10. Then type `python` to open the Python interpreter from the command line shell.

Shell

```
$ python
Python 3.10.4 (tags/v3.10.4:9d38120, Mar 23 2022, 19:00:18)
[MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits", or "license" for more information.
>>>
```

On Mac, the official installer on the Python website is the best approach. In a new browser window go the [Python downloads page](#) and click on the button underneath the text “Download the latest version for Mac OS X.” As of this writing, that is Python 3.10. The package will be in your Downloads directory. Double click on it which launches the Python Installer and follow through the prompts.

To confirm the download was successful, open up a new Terminal window and type `python3 --version`.

Shell

```
$ python3 --version
Python 3.10.4
```

The result should be at least 3.10. Then type `python3` to open the Python interpreter.

Shell

```
$ python3
Python 3.10.4 (v3.10.4:9d38120e33, Mar 23 2022, 17:29:05)
  [Clang 13.0.0 (clang-1300.0.29.30)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

Text Editor

The command line is where we execute commands for our programs but a text editor is where actual code is written. The computer doesn't care what text editor you use—the end result is just code—but a good text editor can provide helpful hints and catch typos for you.

There are many modern text editors available but a very popular one is [Visual Studio Code](#), which is free, easy to install, and enjoys widespread popularity. If you're not already using a text editor, download and install VSCode from the official website.

An optional—but highly recommended—additional step is to take advantage of the large ecosystem of extensions available on VSCode. On Windows, navigate to `File -> Preferences -> Extensions` or on macOS `Code -> Preferences -> Extensions`. This launches a search bar for the extensions marketplace. Enter “python” which will bring up the Microsoft extension as the first result. Install it.

A second extension to add is [Black](#), which is a Python code formatter that has quickly become the default within the Python community. To install Black, open a Terminal window within VSCode by going to `Terminal -> New Terminal` at the top of the page. In the new terminal window opened at the bottom of the page, type `python -m pip install black`. Next, open up the VSCode settings by navigating to `File -> Preferences -> Settings` on Windows or `Code -> Preferences -> Settings` on macOS. Search for “python formatting provider” and select `black` from the dropdown options. Then search for “format on save” and enable “Editor: Format on Save”. Black will now automatically format your code whenever a `*.py` file is saved.

To confirm this is working, use your text editor to create a new file called `hello.py` within the `ch1-setup` directory, located on your Desktop and type in the following using single quotes:

hello.py

```
print('Hello, World!')
```

On save, it should be automatically updated to using double quotes which is [Black's default preference](#): `print("Hello, World!")`. That means everything is working properly.

Install Git

The final step is to install Git, a version control system that is indispensable to modern software development. With Git you can collaborate with other developers, track all your work via commits, and revert to any previous version of your code even if you accidentally delete something important!

On Windows, navigate to the official website at <https://git-scm.com/> and click on the “Download” link which should install the proper version for your computer. Save the file and then open your Downloads folder and double click on the file. This will launch the Git for Windows installer. Click the “Next” button through most of the early defaults as they are fine and can always be updated later as needed. There are two exceptions however: under “Choosing the default editor used by Git” select VS Code not Vim. And in the section on “Adjusting the name of the initial branch in new repositories” select the option to use “main” as opposed to “master” as the default branch name. Otherwise the recommended defaults are fine and can always be tweaked later if needed.

To confirm Git is installed on Windows, close all current shell windows and then open a new one which will load the changes to our PATH variable. Type in `git --version` which should show it is installed.

Shell

```
# Windows
$ git --version
git version 2.35.1.windows.2
```

On macOS, installing Git via Xcode is currently the easiest option. To check if Git is already installed on your computer, type `git --version` in a new terminal window.

Shell

```
# macOS
$ git --version
```

If you do not have Git installed, a popup message will ask if you want to install it as part of “command line developer tools.” Select “Install” which will load Xcode and its command line tools package. Or if you do not see the message for some reason, type `xcode-select --install` instead to install Xcode directly.

Be aware that Xcode is a very large package so the initial download may take some time. Xcode is primarily designed for building iOS apps but also includes many developer features need on macOS. Once the download is complete close all existing terminal shells, open a new window, and type in `git --version` to confirm the install worked.

Shell

```
# macOS
$ git --version
git version 2.32.0 (Apple Git-132)
```

Once Git is installed on your machine we need to do a one-time *system* configuration by declaring the name and email address associated with all your Git commits. We will also set the default branch name to `main`. Within the command line shell type the following two lines. Make sure to update them your name and email address.

Shell

```
$ git config --global user.name "Your Name"
$ git config --global user.email "yourname@email.com"
$ git config --global init.defaultBranch main
```

You can always change these configs later if you desire by retyping the same commands with a new name or email address.

Conclusion

Django is an excellent choice for any developer who wants to build modern, robust web applications with a minimal amount of code. While configuring a software development environment is no easy task you should now have Python 3.10 installed, Git installed, and configured a modern text editor.

In the next chapter we'll learn about Docker and how to configure any computer for Django development with Docker.

Chapter 2: Docker Hello, World!

Properly configuring a local development environment remains a steep challenge despite all the other advances in modern programming. There are simply too many variables: different computers, operating systems, versions of Django, virtual environment options, and so on. When you add in the challenge of working in a team environment where everyone needs to have the same set up the problem only magnifies itself.

In recent years a solution has emerged: [Docker](#). It has quickly become the default choice for many developers working on production-level projects.

With Docker it's finally possible to faithfully and dependably reproduce a production environment locally, everything from the proper Python version to installing Django and running additional services like a production-level database. This means it no longer matter if you are on a Mac, Windows, or Linux computer. Everything is running within Docker itself.

Docker also makes collaboration in teams exponentially easier. Gone are the days of sharing long, out-of-date README files for adding a new developer to a group project. Instead with Docker you simply share two files—a `Dockerfile` and `docker-compose.yml` file—and the developer can have confidence that their local development environment is exactly the same as the rest of the team.

Docker is not a perfect technology. It is still relatively new, complex under-the-hood, and under active development. But the promise that it aspires to—a consistent and shareable developer environment, that can be run either locally on any computer or deployed to any server—makes it a solid choice. It is also widely used among companies at this point so writing a book for “Professionals” and not covering Docker feels shortsighted.

In this chapter we'll learn a little bit more about Docker itself and “Dockerize” our first Django project.

What is Docker?

Docker is a way to isolate an entire operating system via Linux containers which are a type of [virtualization](#). Virtualization has its roots at the beginning of computer science when large, expensive mainframe computers were the norm. How could multiple programmers use the same single machine? The answer was virtualization and specifically [virtual machines](#) which are complete copies of a computer system from the operating system on up.

If you rent space on a cloud provider like *Amazon Web Services (AWS)* they are typically not providing you with a dedicated piece of hardware. Instead you are sharing one physical server with other clients. But because each client has their virtual machine running on the server, it appears to the client as if they have their own server.

This technology is what makes it possible to quickly add or remove servers from a cloud provider. It's largely software behind the scenes, not actual hardware being changed.

What's the downside to a virtual machine? Size and speed. A typical guest operating system can easily take up 700MB of size. So if one physical server supports three virtual machines, that's at least 2.1GB of disk space taken up along with separate needs for CPU and memory resources.

Enter Docker. The key idea is that most computers rely on the same Linux operating system, so what if we virtualized from the Linux layer up instead? Wouldn't that provide a lightweight, faster way to duplicate much of the same functionality? The answer is yes. And in recent years Linux containers have become widely popular. For most applications—especially web applications—a virtual machine provides far more resources than are needed and a container is more than sufficient. This, fundamentally, is what Docker is: a way to implement Linux containers!

An analogy we can use here is that of homes and apartments. Virtual Machines are like homes: stand-alone buildings with their own infrastructure including plumbing and heating, as well as a kitchen, bathrooms, bedrooms, and so on. Docker containers are like apartments: they share common infrastructure like plumbing and heating, but come in various sizes that match the exact needs of an owner.

Virtual Environments vs Containers

Virtual environments are a way to isolate Python packages. Thanks to virtual environments, one computer can run multiple projects locally. For example, Project A might use Python 3.10 and Django 4.0 among other dependencies; whereas Project B uses Python 3.5 and Django 1.11. By creating a new virtual environment for each project and installing Python packages into it, rather than globally on the computer itself, all the necessary Python packages can be maintained, managed, and updated as needed.

There are several ways to implement virtual environments but arguably the simplest is with the [venv](#) module already installed as part of the Python 3 standard library. We will use `venv` shortly to install Django locally on the computer.

The important distinction between virtual environments and Docker containers is that virtual environments *can only isolate Python packages*. They cannot isolate non-Python software like a PostgreSQL or MySQL database. And virtual environments still rely on a global, system-level installation of Python (in other words, on your computer). The virtual environment points to an existing Python installation; it does not contain Python itself.

Linux containers go a step further and isolate the entire operating system, not just the Python parts. In other words, we will install Python itself within Docker as well as install and run a production-level database.

Docker itself is a complex topic and we won't dive that deep into it in this book, however understanding its background and key components is important. If you'd like to learn more about it, I recommend the [Dive into Docker video course](#).

Install Docker

Ok, enough theory. Let's start using Docker and Django together. The first step is to sign up for a free account on [Docker Hub](#) and then install the Docker desktop app on your local machine:

- [Docker for Mac](#)
- [Docker for Windows](#)

This download might take some time as it is a very big file! Feel free to stretch your legs at this point.

Once Docker is done installing we can confirm the correct version is running by typing the command `docker --version` in the command line shell. It should be at least version 18.

Shell

```
$ docker --version
Docker version 20.10.14, build a224086
```

Docker Hello, World

Docker ships with its own “Hello, World” image that is a helpful first step to run. On the command line type `docker run hello-world`. This will download an official Docker image and then run it within a container. We’ll discuss both images and containers in a moment.

Shell

```
$ docker run hello-world
Unable to find image 'hello-world:latest' locally
latest: Pulling from library/hello-world
7050e35b49f5: Pull complete
Digest: sha256:80f31dalac7b312ba29d65080fddf797dd76acfb870e677f390d5acba9741b17
Status: Downloaded newer image for hello-world:latest
```

Hello from Docker!

This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:

1. The Docker client contacted the Docker daemon.
2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
(arm64v8)
3. The Docker daemon created a new container from that image which runs the executable that produces the output you are currently reading.
4. The Docker daemon streamed that output to the Docker client, which sent it to your terminal.

To try something more ambitious, you can run an Ubuntu container with:

```
$ docker run -it ubuntu bash
```

Share images, automate workflows, and more with a free Docker ID:
<https://hub.docker.com/>

For more examples and ideas, visit:
<https://docs.docker.com/get-started/>

The command `docker info` lets us inspect Docker. It will contain a lot of output but focus on the top lines which show we now have 1 container which is stopped and 1 image.

Shell

```
$ docker info
Client:
 Debug Mode: false

Server:
 Containers: 1
  Running: 0
  Paused: 0
  Stopped: 1
 Images: 1
...
```

This means Docker is successfully installed and running.

Install Django

Now we will create a Django “Hello, World” project that runs locally on our computer and then move it entirely within Docker (“Dockerize it”) so you can see how all the pieces fit together.

You can save your Django code anywhere you like but for convenience we will place our code the desktop directory. The command `cd` (change directory) followed by the intended location works on both Windows and macOS computers to navigate to the desktop from the command line.

Shell

```
# Windows
$ cd onedrive\desktop
$ pwd
```

Path

```
C:\Users\wsv\onedrive\desktop
```

```
# macOS
$ cd desktop
$ pwd
/Users/wsv/desktop
```

To make a new directory use the command `mkdir` followed by the name. We will create one called `code` on the Desktop and then within it a new directory called `ch2-hello`.

Shell

```
# Windows
$ mkdir code
$ cd code
$ mkdir ch2-hello
$ cd ch2-hello
```

```
# macOS
$ mkdir code
$ cd code
$ mkdir ch2-hello
$ cd ch2-hello
```

To create a virtual environment within this new directory use the format `python -m venv <name_of_env>` on Windows or `python3 -m venv <name_of_env>` on macOS. Once created, a virtual environment must be *activated*. It is up to the developer to choose a proper environment name but a common choice is to call it `.venv`.

On Windows an *Execution Policy* must be set to enable running scripts. This is a safety precaution. The [Python docs](#) recommend allowing scripts for the `CurrentUser` only, which is what we will do. On macOS there are no similar restrictions on scripts so it is possible to directly run `source .venv/bin/activate`.

Here is what the full commands look like to create and activate a new virtual environment called `.venv`:

Shell

```
# Windows
$ python -m venv .venv
$ Set-ExecutionPolicy -ExecutionPolicy RemoteSigned -Scope CurrentUser
$ .venv\Scripts\Activate.ps1
(.venv) $

# macOS
$ python3 -m venv .venv
$ source .venv/bin/activate
(.venv) $
```

The shell prompt now has the environment name `(.venv)` prefixed which indicates that the virtual environment is active. Any Python packages installed or updated within this location will be confined to the active virtual environment.

Django is hosted on the [Python Package Index \(PyPI\)](#), a central repository for most Python packages. We will use `pip`, the most popular package installer, which comes included with Python 3. To install the latest version of Django use the command `python -m pip install django~=4.0.0`.

The comparison operator `~=` ensures that subsequent security updates for Django, such as 4.0.1, 4.0.2, and so on are automatically installed. Note that while it is possible to use the shorter version of `pip install <package>`, it is a best practice to use the longer but more explicit form of `python -m pip install <package>` to ensure that the correct version of Python is used. This can be an issue if you have multiple versions of Python installed on your computer.

Shell

```
(.venv) $ python -m pip install django~=4.0.0
```

You might see a `WARNING` message about updating `pip` after running these commands. It's always good to be on the latest version of software and to remove the annoying `WARNING` message each time you use `pip`. You can either copy and paste the recommended command or run `python -m pip install --upgrade pip` to be on the latest version.

Shell

```
(.venv) $ python -m pip install --upgrade pip
```

Django Hello, World

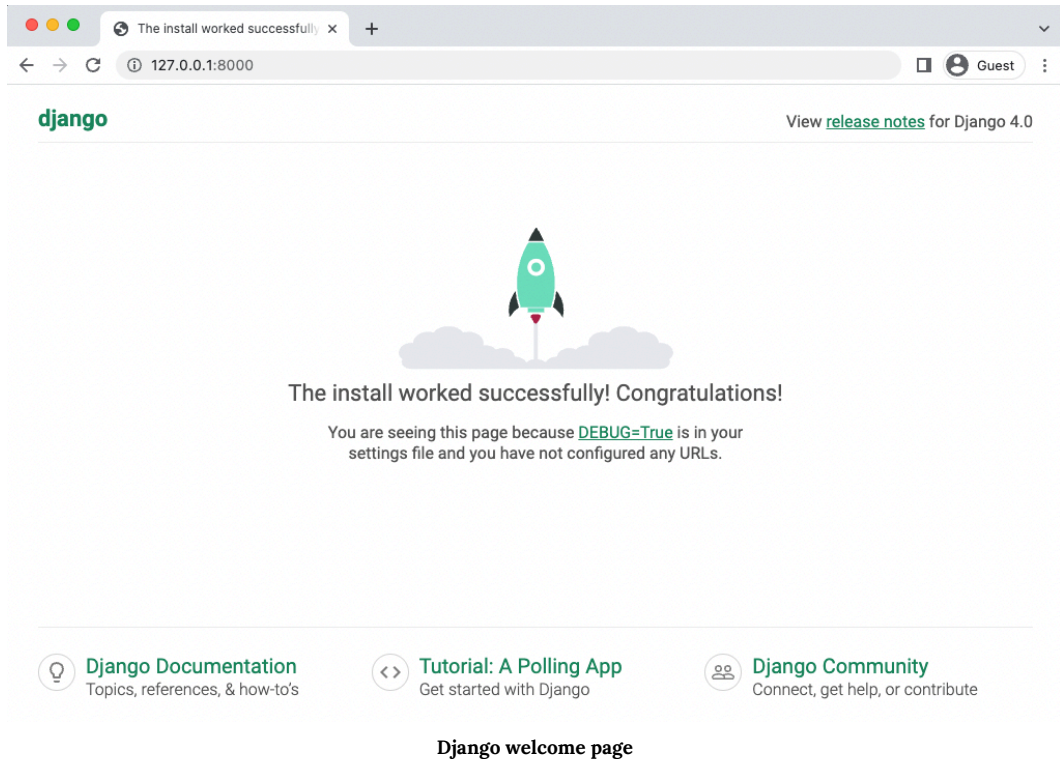
Now we can use the `startproject` command to create a new Django project called `django_project`. Adding a period, `.`, at the end of the command is an optional step but one many Django developers do. Without the period Django adds an additional directory to the project; with the period it does not.

We can also use the `migrate` command to initialize the database and start the local web server with the `runserver` command.

Shell

```
(.venv) $ django-admin startproject django_project .  
(.venv) $ python manage.py migrate  
(.venv) $ python manage.py runserver
```

Assuming everything worked correctly you should now be able to navigate to see the Django Welcome page at `http://127.0.0.1:8000/` in your web browser.



Pages App

Now we will make a simple homepage by creating a dedicated pages app for it. Stop the local server by typing `Control+c` and then use the `startapp` command appending our desired pages name.

Shell

```
(.venv) $ python manage.py startapp pages
```

Django automatically installs a new `pages` directory and several files for us. But even though the app has been created our `django_project` won't recognize it until we add it to the `INSTALLED_APPS` config within the `django_project/settings.py` file. Django loads apps from top to bottom so generally speaking it's a good practice to add new apps below built-in apps they might rely on such as `admin`, `auth`, and all the rest.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    # Local
    "pages.apps.PagesConfig", # new
]
```

Now we can set the URL route for the pages app. Since we want our message to appear on the homepage we'll use the empty string "". Don't forget to add the `include` import on the second line as well.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include # new

urlpatterns = [
    path("admin/", admin.site.urls),
    path("", include("pages.urls")), # new
]
```

Rather than set up a template at this point we can just hardcode a message in our view layer at `pages/views.py` which will output the string "Hello, World!".

Code

```
# pages/views.py
from django.http import HttpResponse

def home_page_view(request):
    return HttpResponse("Hello, World!")
```

What's next? Our last step is to create a `urls.py` file within the `pages` app and link it to `home_page_view`. Do so now with your text editor. Then in the new file `pages/urls.py` import `path` on the top line, add the `home_page_view`, and then set its route to again be the empty string of `""`. Note that we also provide an optional name, `home`, for this route which is a best practice.

Code

```
# pages/urls.py
from django.urls import path

from .views import home_page_view

urlpatterns = [
    path("", home_page_view, name="home")
]
```

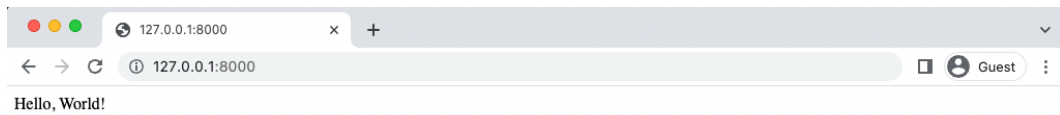
The full flow of our Django homepage is as follows: * when a user goes to the homepage they will first be routed to `django_project/urls.py` * then routed to `pages/urls.py` * and finally directed to the `home_page_view` which returns the string “Hello, World!”

Our work is done for a basic homepage. Start up the local server again.

Shell

```
(.venv) $ python manage.py runserver
```

If you refresh the web browser at `http://127.0.0.1:8000/` it will now output our desired message.



Hello World

The last step is to create a `requirements.txt` file containing a record of all Python packages currently installed in our virtual environment. The command `pip freeze` will output the contents of your current virtual environment and by using the `>` operator we can do all this in one step: output the contents into a new file called `requirements.txt`. If your server is still running enter `Ctrl+c` and `Enter` to exit before entering this command.

Shell

```
(.venv) $ pip freeze > requirements.txt
```

A new `requirements.txt` file will be created. It should contain Django as well as the packages `asgiref` and `sqlparse` which are automatically included when Django is installed.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
sqlparse==0.4.2
```

Now it's time to switch to Docker. Exit our virtual environment since we no longer need it by typing `deactivate` and `Return`.

Shell

```
(.venv) $ deactivate
$
```

How do we know the virtual environment is no longer active? There will no longer be parentheses around the directory name on the command line prompt. Any normal Django commands you try to run at this point will fail. For example, try `python manage.py runserver` to see what happens.

Shell

```
$ python manage.py runserver
...
ModuleNotFoundError: No module named 'django'
```

This means we're fully out of the virtual environment and ready for Docker.

Docker Image

A Docker *image* is a read-only template that describes how to create a Docker *container*. The image is the instructions while the container is the actual running instance of an image. To continue our apartment analogy from earlier in the chapter, an image is the blueprint or set of plans for building an apartment; the container is the actual, fully-built building.

Images are often based on another image with some additional customization. For example, there is a long list of officially supported images for [Python](#) depending on the version and flavor of Python desired.

Dockerfile

For our Django project we need to create a custom image that contains Python but also installs our code and has additional configuration details. To build our own image we create a special file known as a *Dockerfile* that defines the steps to create and run the custom image.

Use your text editor to create a new `Dockerfile` file in the project-level directory next to the `manage.py` file. Within it add the following code which we'll walk through line-by-line below.

Dockerfile

```
# Pull base image
FROM python:3.10.4-slim-bullseye

# Set environment variables
ENV PIP_DISABLE_PIP_VERSION_CHECK 1
ENV PYTHONDONTWRITEBYTECODE 1
ENV PYTHONUNBUFFERED 1

# Set work directory
WORKDIR /code

# Install dependencies
COPY ./requirements.txt .
RUN pip install -r requirements.txt

# Copy project
COPY . .
```

Dockerfiles are read from top-to-bottom when an image is created. The first instruction is a `FROM` command that tells Docker what base image we would like to use for our application. Docker images can be inherited from other images so instead of creating our own base image, we'll use the official Python image that already has all the tools and packages that we need for our Django application. In this case we're using Python 3.10.4 and the much smaller in size `slim` variant that does not contain the common packages contained in the default tag. The tag `bullseye` refers to the latest stable Debian release. It is a good idea to set this explicitly to minimize potential breakage when there are new releases of Debian.

Then we use the `ENV` command to set three environment variables:

- `PIP_DISABLE_PIP_VERSION_CHECK` disables an automatic check for `pip` updates each time
- `PYTHONDONTWRITEBYTECODE` means Python will not try to write `.pyc` files
- `PYTHONUNBUFFERED` ensures our console output is not buffered by Docker

The command `WORKDIR` is used to set a default working directory when running the rest of our commands. This tells Docker to use this path as the default location for all subsequent commands. As a result, we can use relative paths based on the working directory rather than typing out the

full file path each time. In our case the working directory is `/code` but it can often be much longer and something like `/app/src`, `/usr/src/app`, or similar variations depending upon the specific needs of a project.

The next step is to install our dependencies with `pip` and the `requirements.txt` file we already created. The `COPY` command takes two parameters: the first parameter tells Docker what file(s) to copy into the image and the second parameter tells Docker where you want the file(s) to be copied to. In this case we are copying the existing `requirements.txt` file from our local computer into the current working directory which is represented by `..`.

Once the `requirements.txt` file is inside the image we can use our last command, `RUN`, to execute `pip install`. This works exactly the same as if we were running `pip install` locally on our machine, but this time the modules are installed into the image. The `-r` flag tells `pip` to open a file—called `requirements.txt` here—and install its contents. If we did not include the `-r` flag `pip` would try and fail to install `requirements.txt` since it isn't itself an actual Python package.

At the moment we have a new image based on the `slim-bullseye` variant of Python 3.10.4 and have installed our dependencies. The final step is to copy all the files in our current directory into the working directory on the image. We can do this by using the `COPY` command. Remember it takes two parameters so we'll copy the current directory on our local filesystem (`.`) into the working directory (`.`) of the image.

If you're confused right now don't worry. Docker is a lot to absorb but the good news is that the steps involved to "Dockerize" an existing project are very similar.

.dockerignore

A `.dockerignore` file is a best practice way to specify certain files and directories that should not be included in a Docker image. This can help reduce overall image size and improves security by keeping things that are meant to be secret out of Docker.

At the moment we can safely ignore the local virtual environment (`.venv`), our future `.git` directory, and a `.gitignore` file. In your text editor create a new file called `.dockerignore` in the base directory next to the existing `manage.py` file.

.dockerignore

```
.venv  
.git  
.gitignore
```

We now have our complete instructions for creating a custom image but we haven't actually built it yet. The command to do this is unsurprisingly `docker build` followed by the period, `.`, indicating the `Dockerfile` is located in the current directory. There will be a lot of output here. I've only included the first two lines and the last one.

Shell

```
$ docker build .  
[+] Building 9.1s (10/10) FINISHED  
=> [internal] load build definition from Dockerfile  
...  
=> => writing image sha256:89ede1...
```

docker-compose.yml

Our fully-built custom image is now available to run as a container. In order to run the container we need a list of instructions in a file called `docker-compose.yml`. With your text editor create a `docker-compose.yml` file in the project-level directory next to the `Dockerfile`. It will contain the following code.

docker-compose.yml

```
version: "3.9"
services:
  web:
    build: .
    ports:
      - "8000:8000"
    command: python manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
```

On the top line we set the [most recent version](#) of Docker Compose which is currently 3.9. Then we specify which services (or containers) we want to have running within our Docker host. It's possible to have multiple services running, but for now we just have one for web.

Within web we set build to look in the current directory for our Dockerfile. We'll use the Django default ports of 8000 and execute the command to run the local web server. Finally the [volumes](#) mount automatically syncs the Docker filesystem with our local computer's filesystem. This if we make a change to the code within Docker it will automatically be synced with the local filesystem.

The final step is to run our Docker container using the command `docker-compose up`. This command will result in another long stream of output code on the command line.

Shell

```
$ docker-compose up
[+] Building .4s (10/10) FINISHED
=> [internal] load build definition from Dockerfile
...
Attaching to docker-web-1
docker-web-1 | Watching for file changes with StatReloader
docker-web-1 | Performing system checks...
docker-web-1 |
docker-web-1 | System check identified no issues (0 silenced).
docker-web-1 | May 16, 2022 - 18:08:08
docker-web-1 | Django version 4.0.4, using settings 'django_project.settings'
docker-web-1 | Starting development server at http://0.0.0.0:8000/
docker-web-1 | Quit the server with CONTROL-C.
```

To confirm it actually worked, go back to `http://127.0.0.1:8000/` in your web browser. Refresh the page and the “Hello, World” page should still appear.

Django is now running purely within a Docker container. We are not working within a virtual environment locally. We did not execute the `runserver` command. All of our code now exists and our Django server is running within a self-contained Docker container. Success!

We will create multiple Docker images and containers over the course of this book and with practice the flow will start to make more sense.:

- create a `Dockerfile` with custom image instructions
- add a `.dockerignore` file
- build the image
- create a `docker-compose.yml` file
- spin up the container(s)

Stop the currently running container with `Control+c` (press the “Control” and “c” button at the same time) and additionally type `docker-compose down`. Docker containers take up a lot of memory so it’s a good idea to stop them when you’re done using them. Containers are meant to be stateless which is why we use volumes to copy our code over locally where it can be saved.

Shell

```
$ docker-compose down
[+] Running 2/0
  ✖ Container docker-web-1   Removed
  ✖ Network docker_default   Removed
$
```

Whenever any new technology is introduced there are potential security concerns. In Docker’s case, one example is that it sets the default user to `root`. The root user (also known as the “superuser” or “admin”) is a special user account used in Linux for system administration. It is the most privileged user on a Linux system and has access to all commands and files.

The Docker docs contain a section a large section on Security and specifically on [rootless mode](#) to avoid this. We will not be covering it here since this is a book on Django, not Docker, but especially if your website stores sensitive information do review the entire Security section closely before going live.

Git

Git is the version control system of choice these days and we'll use it in this book. Initialize a new repository with `git init` and run `git status` to see which files/directories will be tracked.

Shell

```
$ git init
$ git status
```

Before making our first commit it is always a good idea to create a `.gitignore` file in the project root directory. We will include our virtual environment directory, `.venv`, the `pycache` folder, the local database `db.sqlite3`, and if on macOS `.DS_Store`.

`.gitignore`

```
.venv
__pycache__/
db.sqlite3
.DS_Store # Mac only
```

If you run `git status` again it should show the following:

Shell

```
$ git status
.....
```

Both the database and virtual environment are not ignored by Git. Go ahead and add all current files to Git and create our first commit and message.

Shell

```
$ git add .
$ git commit -m 'ch2-hello'
```

You can compare your code for this chapter with the [official repository](#) available on Github.

Conclusion

Docker is a self-contained environment that includes everything we need for local development: web services, databases, and more if we want. The general pattern will always be the same when using it with Django:

- create a new virtual environment and install Django
- create a new Django project within it
- write a `Dockerfile` and build the initial image
- write a `docker-compose.yml` file and run the container with `docker-compose up`

We will build several more Django projects with Docker so this flow makes more sense, but that's really all there is to it. In the next chapter we'll create a new Django project using Docker and add PostgreSQL in a separate container as our database.

Chapter 3: PostgreSQL

One of the most immediate differences between working on a “toy app” in Django and a production-ready one is the database. Django ships with SQLite as the default choice for local development because it is small, fast, and file-based which makes it easy to use. No additional installation or configuration is required.

However this convenience comes at a cost. Generally speaking SQLite is not a good database choice for professional websites. So while it is fine to use SQLite locally while prototyping an idea, it is rare to actually use SQLite as the database on a production project.

Django ships with built-in support for [five databases](#): PostgreSQL, MariaDB, MySQL, Oracle, and SQLite. We'll be using [PostgreSQL](#) in this book as it is the most popular choice for Django developers, however, the beauty of Django's ORM (Object-Relational-Mapper) is that even if we wanted to use MySQL, MariaDB, or Oracle the actual Django code we write will be almost identical. The Django ORM handles the translation from Python code to SQL configured for each database automatically for us which is quite amazing if you think about it.

The challenge of using non-file based databases is that they must be installed and run locally if you want to faithfully mimic a production environment on your own computer. And we do want that! While Django handles the details of switching between databases for us there are inevitably small, hard-to-catch bugs that can crop up if you use SQLite for local development but a different database in production. Therefore a best practice is to use the same database locally and in production.

In this chapter we'll start a new Django project with a SQLite database and then switch over to both Docker and PostgreSQL.

Django Set Up

On the command line make sure you've navigated back to the `code` folder on our desktop. You can do this two ways. Either type `cd ..` to move “up” a level so if you are currently in

Desktop/code/hello you will move to Desktop/code. Or you can simply type `cd onedrive\desktop` on Windows or `cd ~/desktop/code` on macOS which will take you directly to the code directory. Then create a new directory called `ch3-postgresql` for this chapter's code.

Shell

```
# Windows
$ cd onedrive\desktop
$ mkdir ch3-postgresql

# macOS
$ cd ~/desktop/code
$ mkdir ch3-postgresql
```

We will follow the standard steps for creating a new Django project: make a dedicated virtual environment, activate it, and install Django.

Shell

```
# Windows
$ python -m venv .venv
$ Set-ExecutionPolicy RemoteSigned -Scope CurrentUser
$ .venv\Scripts\Activate.ps1
(.venv) $ python -m pip install django~=4.0.0

# macOS
$ python3 -m venv .venv
$ source .venv/bin/activate
(.venv) $ python3 -m pip install django~=4.0.0
```

Next we can create a new project called `django_project`, migrate our database to initialize it, and use `runserver` to start the local server.

Shell

```
(.venv) $ django-admin startproject django_project .
(.venv) $ python manage.py migrate
(.venv) $ python manage.py runserver
```

Normally I don't recommend running `migrate` on new projects until *after* a custom user model has been configured. Otherwise Django will bind the database to the built-in user model which

is difficult to modify later on in the project. We'll cover this properly in Chapter 3 but since this chapter is primarily for demonstration purposes, using the default User model here is a one-time exception.

Confirm everything worked by navigating to `http://127.0.0.1:8000/` in your web browser. You may need to refresh the page but should see the familiar Django welcome page.

The last step before switching over to Docker is creating a `requirements.txt` file using the command we learned in the previous chapter.

Shell

```
(.venv) $ pip freeze > requirements.txt
```

This will generate a new `requirements.txt` file containing the pinned contents of our current virtual environment.

Docker

To switch over to Docker first deactivate our virtual environment and then in your text editor create new `Dockerfile` and `docker-compose.yml` files which will control our Docker image and container respectively.

Shell

```
(.venv) $ deactivate  
$
```

The `Dockerfile` is the same as in Chapter 1.

Dockerfile

```
# Pull base image
FROM python:3.10.4-slim-bullseye

# Set environment variables
ENV PIP_DISABLE_PIP_VERSION_CHECK 1
ENV PYTHONDONTWRITEBYTECODE 1
ENV PYTHONUNBUFFERED 1

# Set work directory
WORKDIR /code

# Install dependencies
COPY ./requirements.txt .
RUN pip install -r requirements.txt

# Copy project
COPY . .
```

Before building the image make sure to create a `.dockerignore` file.

.dockerignore

```
.venv
.git
.gitignore
```

Notice that if you build the initial image using the `docker build .` command it is much, much faster than the previous chapter.

Shell

```
$ docker build .
...
---> Using cache
```

That's because whenever you build a new `Dockerfile`, Docker will automatically check if it can use the cached results of previous builds. And since this `Dockerfile` is the same as the one from Chapter 1 everything is the same except for the final `COPY` command that syncs local files with those on the container's filesystem.

This caching means that the order of a `Dockerfile` is important for performance reasons. In order to avoid constantly invalidating the cache we start the `Dockerfile` with commands that are less likely to change while putting commands that are more likely to change, like `COPY`ing the local filesystem, at the end.

Time now for the `docker-compose.yml` file which also matches what we saw previously in Chapter 1.

docker-compose.yml

```
version: "3.9"

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
```

Detached Mode

We'll start up our container now but this time in detached mode which requires either the `-d` or `-detach` flag (they do the same thing).

Shell

```
$ docker-compose up -d
```

Detached mode runs [containers in the background](#), which means we can use a single command line tab without needing a separate one open as well. This saves us from switching back and forth between two command line tabs constantly. The downside is that if/when there is an error, the output won't always be visible. So if your screen does not match this book at some point, try typing `docker-compose logs` to see the current output and debug any issues.

You likely will see a "Warning: Image for service web was built because it did not already exist" message at the bottom of the command. Docker automatically created a new image for us within

the container. As we'll see later in the book, adding the `--build` flag to force an image build is necessary when software packages are updated because, by default, Docker will look for a local cached copy of software and use that which improves performance.

To confirm things are working properly go back to `http://127.0.0.1:8000/` in your web browser. Refresh the page to see the Django welcome page again.

Since we're working *within Docker* now as opposed to locally we must preface traditional commands with `docker-compose exec [service]` where we specify the name of the service. For example, to create a superuser account instead of typing `python manage.py createsuperuser` the updated command would now look like the line below, using the web service.

Shell

```
$ docker-compose exec web python manage.py createsuperuser
```

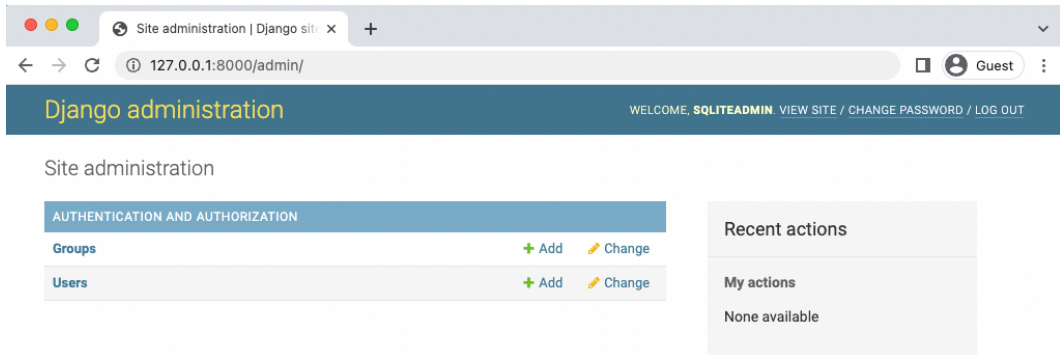
Note: If you are on a newer M1-based macOS computer it's possible this command will yield the following cryptic error: `django.db.utils.OperationalError: SCRAM authentication requires libpq version 10 or above`. Currently there is a bug upstream in `libpq` that's building against the wrong library version on ARM. The fix is to update the first line of your `Dockerfile` to specify the proper local platform by adding `--platform=linux/amd64` to the initial `FROM` command that installs Python.

Dockerfile

```
# Pull base image
FROM --platform=linux/amd64 python:3.10.4-slim-bullseye
...
```

For the username choose `sqliteadmin`, `sqliteadmin@email.com` as the email address, and select the password of your choice. I often use `testpass123`.

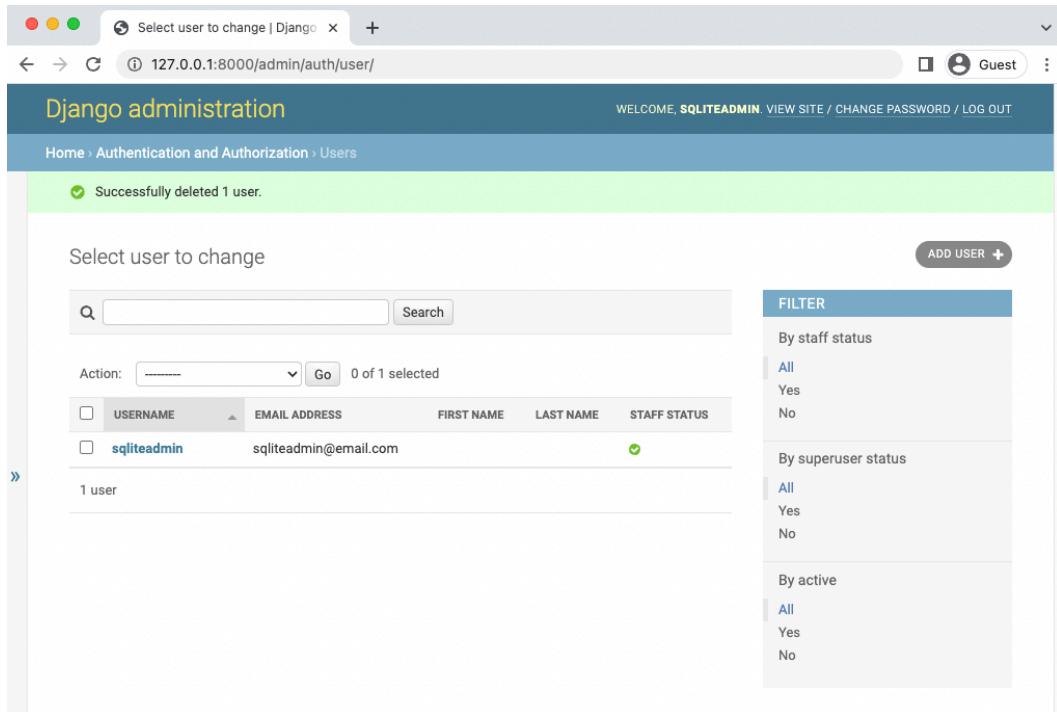
Then navigate directly into the admin at `http://127.0.0.1:8000/admin` and log in. You will be redirected to the admin homepage. Note in the upper right corner `sqliteadmin` is the username.



Django sqlitedadmin

Django has impressive support for multiple languages so if you'd like to see the Admin, forms, and other default messages in language other than English, try adjusting the `LANGUAGE_CODE` configuration in `django_project/settings.py` which is automatically set to American English, `en-us`.

Moving along, if you click on the `Users` button it takes us to the `Users` page where we can confirm only one user has been created.



Admin Users page

It's important to highlight another aspect of Docker at this point: so far we've been updating our database—currently represented by the `db.sqlite3` file—within Docker. That means the actual `db.sqlite3` file is changing each time. And thanks to the `volumes` mount in our `docker-compose.yml` config each file change has been copied over into a `db.sqlite3` file on our local computer too. You could quit Docker, start the shell, start the server with `python manage.py runserver`, and see the exact same admin login at this point because the underlying SQLite database is the same.

PostgreSQL

PostgreSQL is a database that can be used by almost any programming language. But if you think about it, how does a programming language—and they all vary in some way or another—connect to the database itself?

The answer is via a database adapter! And that's what [Pycopg](#) is, the most popular database adapter for Python. If you'd like to learn more about how Pycopg works here is a link to [a fuller description](#) on the official site.

Pycopg 3.0 was recently released but many packages and hosting providers are still focused on Pycopg2 so that's what we'll use. Note that there are actually two versions of Pycopg2 available: `pycopg2` and `pycopg2-binary`. We will use the binary version in this book because it is simpler to use and works just fine for most websites. Using the non-binary version requires multiple additional steps of configuration and is only relevant to truly massive websites. If way down the line you find slowness with your database, investigating `pycopg2` vs `pycopg2-binary` is a worthy use of time. But starting out it is not.

To install it first stop running the Docker container with `docker-compose down`.

Shell

```
$ docker-compose down
```

It's important to pause right now and think about what it means to install a package into Docker as opposed to a local virtual environment. In a traditional project we'd run the command `python -m pip install pycopg2-binary==2.9.3` from the command line to install Pycopg2. But we're working with Docker now.

There are two options. The first is to install `pycopg2-binary` locally and then `pip freeze` our virtual environment to update `requirements.txt`. If we were going to use the local environment this might make sense. But since we are committed to Docker we can skip that step and instead just update `requirements.txt` with the `pycopg2-binary` package. We don't need to update the actual virtual environment further because it is unlikely we'll be using it. And if we ever did we can just update it based on `requirements.txt` anyway.

In your text editor open the existing `requirements.txt` file and add `pycopg2-binary==2.9.3` to the bottom.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
sqlparse==0.4.2
psycopg2-binary==2.9.3
```

At the end of our PostgreSQL configuration changes we will build the new image and spin up our containers. But not yet.

docker-compose.yml

In the existing `docker-compose.yml` file add a new service called `db`. This means there will be two separate containers running within our Docker host: `web` for the Django local server and `db` for our PostgreSQL database.

The `web` service depends on the `db` service to run so we'll add a line called `depends_on` to `web` signifying this.

Within the `db` service we specify which version of PostgreSQL to use. As of this writing, Heroku supports version 13 as the latest release so that is what we will use. Docker containers are ephemeral meaning when the container stops running all information is lost. This would obviously be a problem for our database! The solution is to create a `volumes` mount called `postgres_data` and then bind it to a dedicated directory within the container at the location `/var/lib/postgresql/data/`. The final step is to add a [trust authentication](#) to the `environment` for the `db`. For large databases with many database users it is recommended to be more explicit with permissions, but this setting is a good choice when there is just one developer.

Here is what the updated file looks like:

docker-compose.yml

```
version: "3.9"

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
    depends_on:
      - db
  db:
    image: postgres:13
    volumes:
      - postgres_data:/var/lib/postgresql/data/
    environment:
      - "POSTGRES_HOST_AUTH_METHOD=trust"

volumes:
  postgres_data:
```

DATABASES

The third and final step is to update the `django_project/settings.py` file to use PostgreSQL and not SQLite. Within your text editor scroll down to the DATABASES config.

By default Django specifies `sqlite3` as the database engine, gives it the name `db.sqlite3`, and places it at `BASE_DIR` which means in our project-level directory.

Code

```
# django_project/settings.py
DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.sqlite3",
        "NAME": BASE_DIR / "db.sqlite3",
    }
}
```

To switch over to PostgreSQL we will update the `ENGINE` configuration. PostgreSQL requires a `NAME`, `USER`, `PASSWORD`, `HOST`, and `PORT`. For convenience we'll set the first three to `postgres`, the `HOST` to `db` which is the name of our service set in `docker-compose.yml`, and the `PORT` to 5432 which is the default PostgreSQL `port`.

Code

```
# django_project/settings.py
DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.postgresql",
        "NAME": "postgres",
        "USER": "postgres",
        "PASSWORD": "postgres",
        "HOST": "db", # set in docker-compose.yml
        "PORT": 5432, # default postgres port
    }
}
```

And that's it! We can build our new image containing `psycopg2-binary` and spin up the two containers in detached mode with the following single command:

Shell

```
$ docker-compose up -d --build
```

If you refresh the Django welcome page at `http://127.0.0.1:8000/` it should work which means Django has successfully connected to PostgreSQL via Docker.

New Database

Since we are using PostgreSQL now, not SQLite, our database is empty. If you look at the current logs again by typing `docker-compose logs` you'll see complaints like "You have 18 unapplied migrations(s)".

To reinforce this point visit the Admin at `http://127.0.0.1:8000/admin/` and log in. Will our previous superuser account of `sqliteadmin` and `testpass123` work?

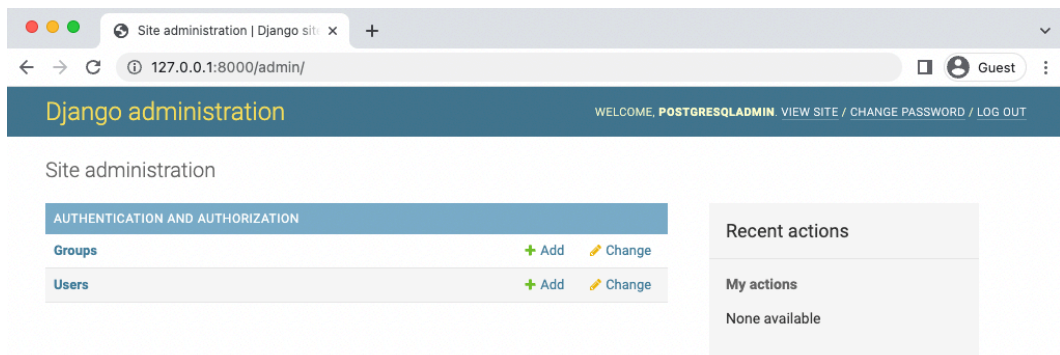
Nope! We see `ProgrammingError` at `/admin`. To fix this situation, we can both migrate and create a superuser *within* Docker that will access the PostgreSQL database.

Shell

```
$ docker-compose exec web python manage.py migrate
$ docker-compose exec web python manage.py createsuperuser
```

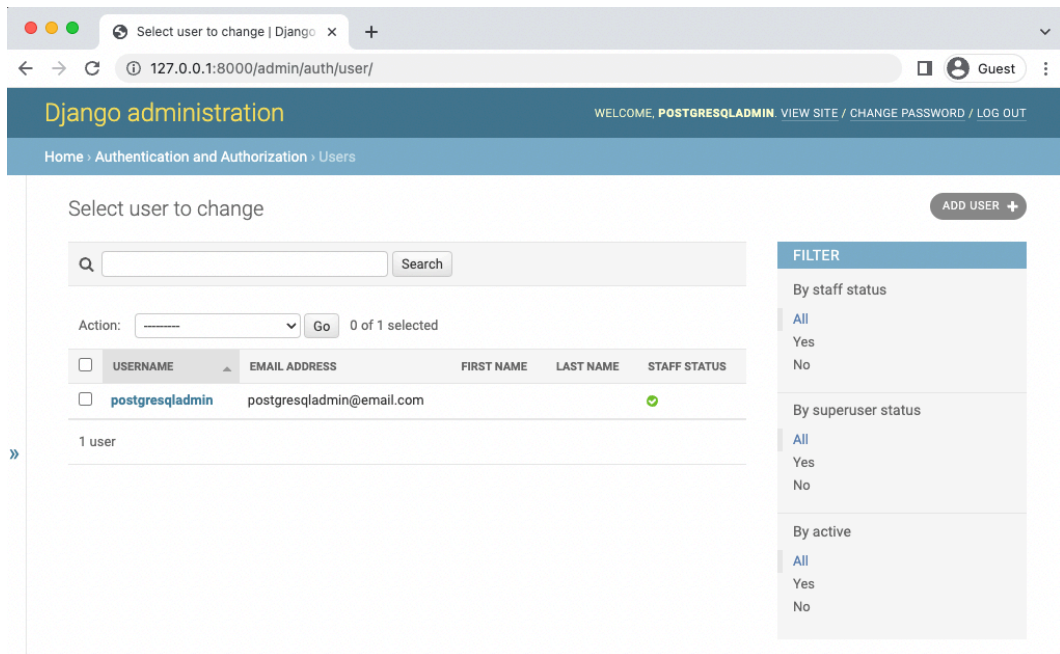
What should we call our superuser? Let's use `postgresqladmin` and for testing purposes set the email to `postgresqladmin@email.com` and the password to `testpass123`.

In your web browser navigate to the admin page at `http://127.0.0.1:8000/admin/` and enter in the new superuser log in information.



Admin with postgresadmin

In the upper right corner it shows that we are logged in with `postgresadmin` now not `sqliteadmin`. Also, you can click on the `Users` tab on the homepage and visit the `Users` section to see our one and only user is the new superuser account.



Admin users

Remember to stop our running container with `docker-compose down`.

Shell

```
$ docker-compose down
```

Git

Let's save our changes with Git. Initialize a new Git repository and check the current status.

Shell

```
$ git init
$ git status
```

Before creating the first commit it is always a good idea to add a `.gitignore` file to the project root directory. Ours will have four lines right now.

.gitignore

```
.venv
__pycache__/\n db.sqlite3\n .DS_Store  # Mac only
```

Use `git status` again to check that both are no longer being tracked by Git and then add all other changes and include a commit message.

Shell

```
$ git status\n$ git add .\n$ git commit -m 'ch3'
```

The official source code for Chapter 3 is [available on Github](#).

Conclusion

The goal of this chapter was to demonstrate how Docker and PostgreSQL work together on a Django project. Switching between a SQLite database and a PostgreSQL is a mental leap for many developers initially.

The key point is that with Docker we don't need to be in a local virtual environment anymore. Docker is our virtual environment...and our database and more if desired. The Docker host essentially replaces our local operating system and within it we can run multiple containers, such as for our web app and for our database, which can all be isolated and run separately.

In the next chapter we will start our online Bookstore project. Let's begin!

Chapter 4: Bookstore Project

It is time to build the main project of this book, an online Bookstore. In this chapter we will start a new project, switch over to Docker, add a custom user model, and write our first tests.

Let's start by creating a new Django project. From the desktop create a new directory called `ch4-bookstore` and then create and activate a new Python virtual environment. From there we will install both Django and the `psycopg2-binary` adapter necessary to connect to a PostgreSQL database.

Shell

```
# Windows
$ cd onedrive\desktop
$ mkdir ch4-bookstore
$ cd ch4-bookstore
$ python -m venv .venv
$ Set-ExecutionPolicy -ExecutionPolicy RemoteSigned -Scope CurrentUser
$ .venv\Scripts\Activate.ps1
(.venv) $ python -m pip install django~=4.0.0 psycopg2-binary==2.9.3

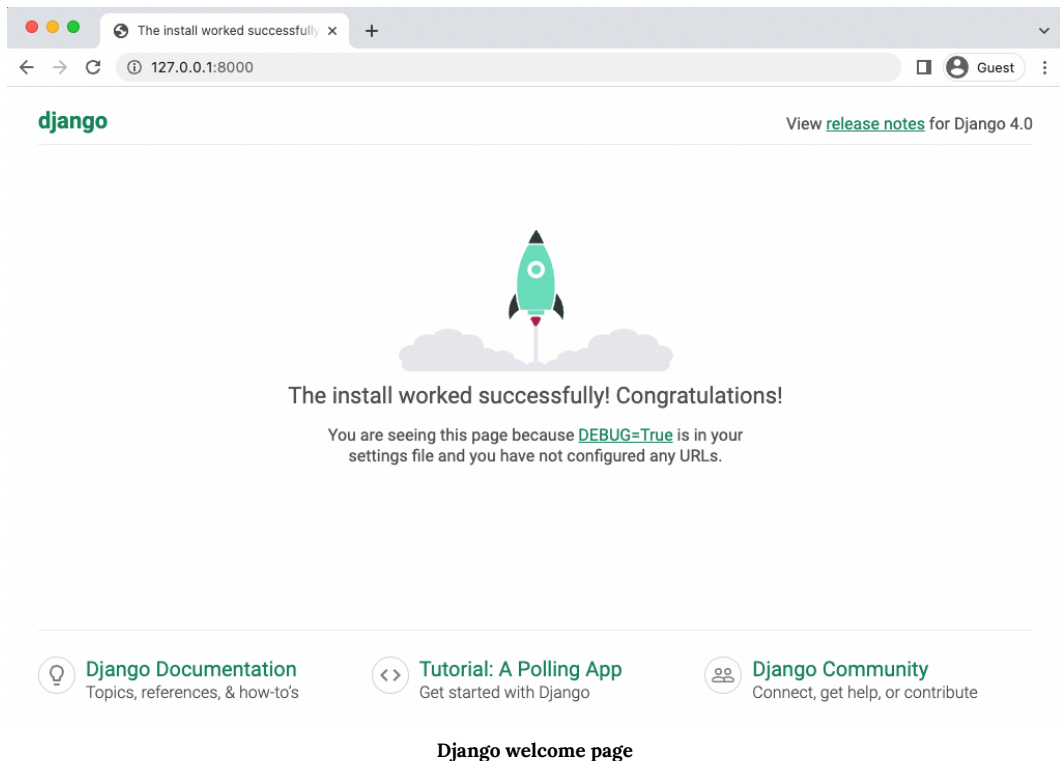
# macOS
$ cd ~/desktop/code
$ mkdir ch4-bookstore
$ cd ch4-bookstore
$ python3 -m venv .venv
$ source .venv/bin/activate
(.venv) $ python3 -m pip install django~=4.0.0 psycopg2-binary==2.9.3
```

We use the `startproject` command to make our new Django project called `django_project`. Make sure you don't forget that period, `.`, at the end of the command or else Django will create an extra directory which we don't need. Then use `runserver` to start the local Django web server and confirm everything is working correctly.

Shell

```
(.venv) $ django-admin startproject django_project .  
(.venv) $ python manage.py runserver
```

In your web browser go to `http://127.0.0.1:8000/` and you should see the friendly Django welcome page.



On the command line you will likely see a warning about “18 unapplied migration(s)”. It’s safe to ignore this for now since we’re about to switch over to Docker and PostgreSQL.

Lastly stop the local server with `Control+c` and in your text editor create a `requirements.txt` file with the current contents of our Python virtual environment.

Shell

```
(.venv) $ pip freeze > requirements.txt
```

The new file should contain the three packages installed with Django—Django, asgiref, sqlparse—as well as psycopg2-binary.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycopg2-binary==2.9.3
sqlparse==0.4.2
```

Docker

We can now switch over to Docker in our project. Go ahead and stop the local server Control+c and also exit the virtual environment shell.

Shell

```
(.venv) $ deactivate
$
```

Docker should already be installed and the desktop app running from the previous chapter. We will need a Dockerfile for our image and a docker-compose.yml file to run the container. This process is identical to what we just did in Chapter 3.

In your text editor create a new Dockerfile and docker-compose.yml file in the base directory next to the existing manage.py file. Then add the following code to each.

Dockerfile

```
# Pull base image
FROM python:3.10.4-slim-bullseye

# Set environment variables
ENV PIP_DISABLE_PIP_VERSION_CHECK 1
ENV PYTHONDONTWRITEBYTECODE 1
ENV PYTHONUNBUFFERED 1

# Set work directory
WORKDIR /code

# Install dependencies
COPY ./requirements.txt .
RUN pip install -r requirements.txt

# Copy project
COPY . .
```

docker-compose.yml

```
version: "3.9"

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
    depends_on:
      - db
  db:
    image: postgres:13
    volumes:
      - postgres_data:/var/lib/postgresql/data/
    environment:
      - "POSTGRES_HOST_AUTH_METHOD=trust"

volumes:
  postgres_data:
```

Remember that if you are on a newer M1-based macOS computer it may be necessary to specify the proper local platform by adding `--platform=linux/amd64` to the initial `FROM` command that installs Python.

Dockerfile

```
# Pull base image
FROM --platform=linux/amd64 python:3.10.4-slim-bullseye
...
```

Before building the image make sure to create a `.dockerignore` file and `.gitignore` file too.

.dockerignore

```
.venv
.git
.gitignore
```

.gitignore

```
.venv
__pycache__/
db.sqlite3
.DS_Store # Mac only
```

Now we can build our image and run the containers with one command.

Shell

```
$ docker-compose up -d --build
```

Go to the web browser now at `http://127.0.0.1:8000/` and click refresh. It should be the same friendly Django welcome page albeit now running inside of Docker.

PostgreSQL

The last step is switching over to PostgreSQL. Even though we already installed `psycopg2-binary` and have PostgreSQL available in our `docker-compose.yml` file, we still must explicitly tell Django

what DATABASE to use which we can do in the `django_project/settings.py` file. Remember that by default Django will use a SQLite database instead.

The updated code is the same as in the previous chapter.

Code

```
# django_project/settings.py
DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.postgresql",
        "NAME": "postgres",
        "USER": "postgres",
        "PASSWORD": "postgres",
        "HOST": "db",
        "PORT": 5432,
    }
}
```

Make sure to refresh the web browser for the homepage to confirm everything still works correctly.

Custom User Model

Now we come to new material! We begin by implementing a custom user model which the official Django documentation [“highly recommends.”](#) Why? Because you *will* need to make changes to the built-in User model at some point in your project’s life and if you have not started with a custom user model from the very first `migrate` command you run, then you’re in for a world of hurt because `User` is tightly interwoven with the rest of Django internally. It is challenging to switch over to a custom user model mid-project.

A point of confusion for many people is that custom user models were only added in Django 1.5. Up until that point the recommended approach was to add a [OneToOneField](#), often called a Profile model, to `User`. You’ll often see this set up in older projects.

But these days using a custom user model is the more common approach. However as with many things Django-related, there are implementation choices: either extend [AbstractUser](#) which

keeps the default User fields and permissions or extend `AbstractBaseUser` which is even more granular, and flexible, but requires more work.

We'll stick with the simpler `AbstractUser` in this book as `AbstractBaseUser` can be added later if needed.

There are four steps for adding a custom user model to our project:

1. Create a `CustomUser` model
2. Update `django_project/settings.py`
3. Customize `UserCreationForm` and `UserChangeForm`
4. Add the custom user model to `admin.py`

The first step is to create a `CustomUser` model which will live within its own app. I like to name this app `accounts`. Going forward we'll run the majority of our commands within Docker itself. Because we configured a volumes within the web service of `docker-compose.yml` any file system changes within Docker will be reflected in the local file system.

Shell

```
$ docker-compose exec web python manage.py startapp accounts
```

Create a new `CustomUser` model which extends `AbstractUser`. That means we're essentially making a copy where `CustomUser` now has inherited all the functionality of `AbstractUser`, but we can override or add new functionality as needed. We're not making any changes yet so include the Python `pass` statement which acts as a placeholder for our future code.

Code

```
# accounts/models.py
from django.contrib.auth.models import AbstractUser
from django.db import models

class CustomUser(AbstractUser):
    pass
```

Now go in and update our `settings.py` file in the `INSTALLED_APPS` section to tell Django about our new accounts app. We also want to add a `AUTH_USER_MODEL` config at the bottom of the file which will cause our project to use `CustomUser` instead of the default `User` model.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    # Local
    "accounts.apps.AccountsConfig", # new
]
...
AUTH_USER_MODEL = "accounts.CustomUser" # new
```

Time to create a migrations file for the changes. We'll add the optional app name `accounts` to the command so that only changes to that app are included.

Shell

```
$ docker-compose exec web python manage.py makemigrations accounts
Migrations for 'accounts':
  accounts/migrations/0001_initial.py
    - Create model CustomUser
```

Then run migrate to initialize the database for the very first time.

Shell

```
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: accounts, admin, auth, contenttypes, sessions
Running migrations:
  No migrations to apply.
```

Custom User Forms

A user model can be both created and edited within the Django admin. So we'll need to update the built-in forms too to point to CustomUser instead of User. In your text editor create a new file called `accounts/forms.py` and type in the following code to switch over to CustomUser.

Code

```
# accounts/forms.py
from django.contrib.auth import get_user_model
from django.contrib.auth.forms import UserCreationForm, UserChangeForm

class CustomUserCreationForm(UserCreationForm):
    class Meta:
        model = get_user_model()
        fields = (
            "email",
            "username",
        )

class CustomUserChangeForm(UserChangeForm):
    class Meta:
```

```
model = get_user_model()
fields = (
    "email",
    "username",
)
```

At the very top we've imported CustomUser model via `get_user_model` which looks to our `AUTH_USER_MODEL` config in `settings.py`. This might feel a bit more circular than directly importing CustomUser here, but it enforces the idea of making one single reference to the custom user model rather than directly referring to it all over our project.

Next we import `UserCreationForm` and `UserChangeForm` which will both be extended.

Then create two new forms—`CustomUserCreationForm` and `CustomUserChangeForm`—that extend the base user forms imported above and specify swapping in our CustomUser model and displaying the fields `email` and `username`. The `password` field is implicitly included by default and so does not need to be explicitly named here as well.

Custom User Admin

Finally we have to update our `accounts/admin.py` file. The admin is a common place to manipulate user data and there is tight coupling between the built-in User and the admin.

We'll extend the existing `UserAdmin` into `CustomUserAdmin` and tell Django to use our new forms and custom user model. We can also list [any user attributes](#) we want but for now will just focus on three: `email`, `username`, and `superuser` status.

Code

```
# accounts/admin.py
from django.contrib import admin
from django.contrib.auth import get_user_model
from django.contrib.auth.admin import UserAdmin

from .forms import CustomUserCreationForm, CustomUserChangeForm

CustomUser = get_user_model()

class CustomUserAdmin(UserAdmin):
    add_form = CustomUserCreationForm
    form = CustomUserChangeForm
    model = CustomUser
    list_display = [
        "email",
        "username",
        "is_superuser",
    ]

admin.site.register(CustomUser, CustomUserAdmin)
```

Phew. A bit of code upfront but this saves a ton of heartache later on.

Superuser

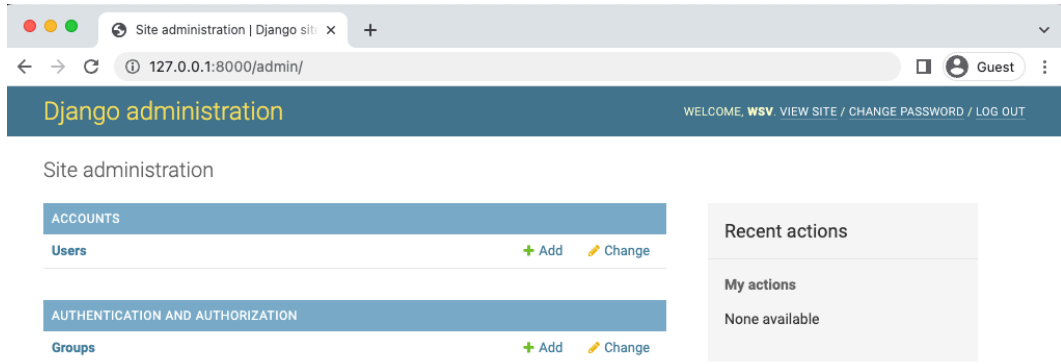
A good way to confirm our custom user model is up and running properly is to create a superuser account so we can log into the admin. This command will access `CustomUserCreationForm` under the hood.

Shell

```
$ docker-compose exec web python manage.py createsuperuser
```

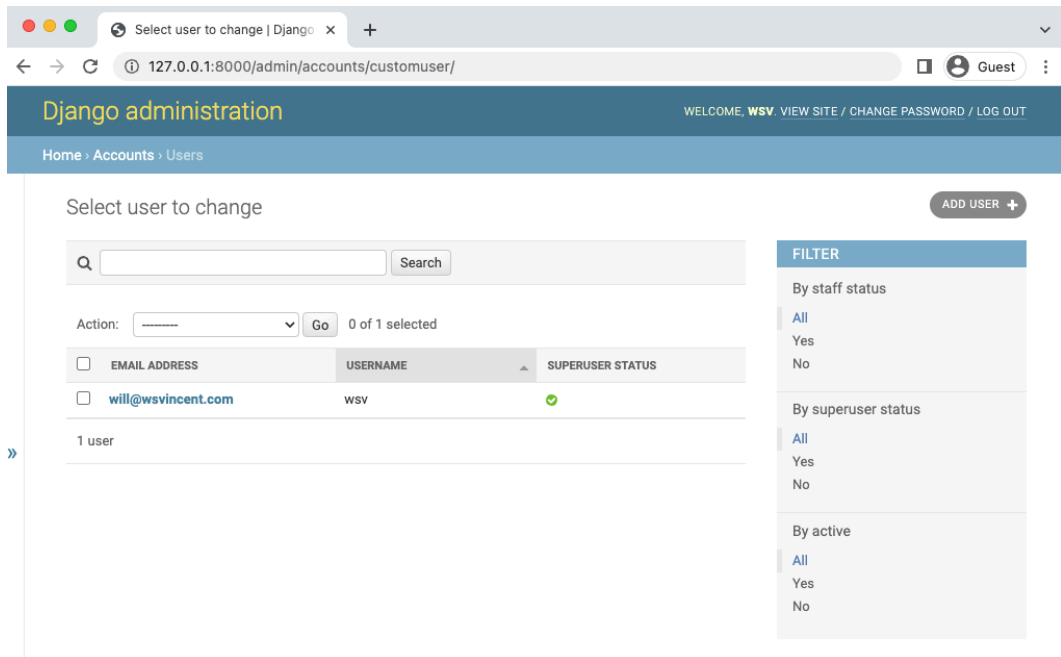
I've used the username `wsv`, email of `will@wsvincent.com`, and password `testpass123`. You can use your own preferred variations here.

In your web browser open the page `http://127.0.0.1:8000/admin` and log in. You should see your superuser name in the upper right corner on the post-log in page.



Django admin homepage

You can also click on the Users section to see the email and username of your superuser account.



Django admin users page

Tests

Since we've added new functionality to our project we should test it. Whether you are a solo developer or working on a team, tests are important. In the words of Django co-founder Jacob Kaplan-Moss, "Code without tests is broken as designed."

There are two main types of tests:

- *Unit tests* are small, fast, and isolated to a specific piece of functionality
- *Integration tests* are large, slow, and used for testing an entire application or a user flow like payment that covers multiple screens

You should write many unit tests and a small number of integration tests.

The Python programming language contains its own [unit testing framework](#) and Django's [automated testing framework](#) extends this with multiple additions into a web context. There is no excuse for not writing a lot of tests; they will save you time.

It's important to note that not everything needs to be tested. For example, any built-in Django features already contain tests in the source code. If we were using the default `User` model in our project we would not need to test it. But since we've created a `CustomUser` model we should.

Unit Tests

To write unit tests in Django we use [TestCase](#) which is, itself, an extension of Python's [TestCase](#). Our `accounts` app already contains a `tests.py` file which is automatically added when the `startapp` command is used. Currently it is blank. Let's fix that!

Each method must be prefaced with `test` in order to be run by the Django test suite. It is also a good idea to be overly descriptive with your unit test names since mature projects have hundreds if not thousands of tests!

Code

```
# accounts/tests.py
from django.contrib.auth import get_user_model
from django.test import TestCase

class CustomUserTests(TestCase):
    def test_create_user(self):
        User = get_user_model()
        user = User.objects.create_user(
            username="will", email="will@email.com", password="testpass123"
        )
        self.assertEqual(user.username, "will")
        self.assertEqual(user.email, "will@email.com")
        self.assertTrue(user.is_active)
        self.assertFalse(user.is_staff)
        self.assertFalse(user.is_superuser)

    def test_create_superuser(self):
        User = get_user_model()
        admin_user = User.objects.create_superuser(
            username="superadmin", email="superadmin@email.com", password="testpass123"
        )
        self.assertEqual(admin_user.username, "superadmin")
        self.assertEqual(admin_user.email, "superadmin@email.com")
        self.assertTrue(admin_user.is_active)
        self.assertTrue(admin_user.is_staff)
        self.assertTrue(admin_user.is_superuser)
```

We have imported both `get_user_model` and `TestCase` before creating a `CustomUserTests` class. Within it are two separate tests. `test_create_user` confirms that a new user can be created. First we set our user model to the variable `User` and then create one via the manager method `create_user` which does the actual work of creating a new user with the proper permissions.

For `test_create_superuser` we follow a similar pattern but reference `create_superuser` instead of `create_user`. The difference between the two users is that a superuser should have both `is_staff` and `is_superuser` set to `True`.

To run our tests within Docker we'll prefix `docker-compose exec web` to the traditional command `python manage.py test`.

Shell

```
$ docker-compose exec web python manage.py test
Found 2 test(s).
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
..
-----
Ran 2 tests in 0.115s
```

```
OK
Destroying test database for alias 'default'...
```

All the tests pass so we can proceed.

Git

We've accomplished quite a lot in this chapter so it is a good point to pause and commit our work by initializing a new Git repository, adding changes, and including a commit message.

Shell

```
$ git init
$ git status
$ git add .
$ git commit -m 'ch4'
```

You can compare with the [official source code for this chapter on Github](#).

Conclusion

Our Bookstore project is now running with Docker and PostgreSQL and we've configured a custom user model. Next up will be a pages app for our static pages.

Chapter 5: Pages App

Let's build a homepage for our new project. For now this will be a static page meaning it will not interact with the database in any way. Later on it will be a dynamic page displaying books for sale but... one thing at a time.

It's common to have multiple static pages in even a mature project such as an About page so let's create a dedicated pages app for them. On the command line use the `startapp` command again to make a pages app.

Shell

```
$ docker-compose exec web python manage.py startapp pages
```

Then add it to our `INSTALLED_APPS` setting. We'll also update `TEMPLATES` so that Django will look for a project-level templates folder. By default Django looks within each app for a templates folder, but organizing all templates in one space is easier to manage.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig", # new
]

TEMPLATES = [
    {
        ...
        "DIRS": [BASE_DIR / "templates"], # new
    },
]
```

```
    ...  
}  
]
```

Note that updating the `DIRS` setting means that Django will *also* look in this new folder; it will still look for any templates folders within an app.

Templates

Moving on it is time to create that new templates directory on the command line.

Shell

```
$ mkdir templates
```

Then with your text editor create two new files within it: `templates/_base.html` and `templates/home.html`. The first base level file will be inherited by all other files; `home.html` will be our homepage.

Why call the base template `_base.html` with the underscore instead of `base.html`? This is an optional practice but some developers prefer to add an underscore, `_`, to files solely meant to be inherited by other files.

In the base file we'll include the bare minimum needed and add block tags for both `title` and `content`. Block tags give higher-level templates the option to override just the content within the tags. For example, the homepage will have a title of “Home” but we want that to appear between `html <title></title>` tags. Using block tags make it easier to update this content, as needed, in inherited templates.

Why use the name `content` for the main content of our project? This name could be anything—`main` or some other generic indicator—but using `content` is a common naming convention in the Django world. Can you use something else? Absolutely. Is `content` the most common one you'll see? Yes.

Code

```
<!-- templates/_base.html -->
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <title>{% block title %}Bookstore{% endblock title %}</title>
</head>
<body>
  <div class="container">
    {% block content %}
    {% endblock content %}
  </div>
</body>
</html>
```

Now for the homepage which will simply say “This is our home page.” for now.

Code

```
<!-- templates/home.html -->
{% extends "_base.html" %}

{% block title %}Home{% endblock title %}

{% block content %}
  <h1>This is our home page.</h1>
{% endblock content %}
```

URLs and Views

Every webpage in our Django project needs a `urls.py` and `views.py` file to go along with the template. For beginners the fact that order doesn’t really matter here—we need all 3 files and really often a 4th, `models.py`, for the database—is confusing. Generally I prefer to start with the `urls` and work from there but there is no “right way” to build out this connected web of Django files.

Let’s start with our project-level `urls.py` to set the proper path for webpages within the `pages` app. Since we want to create a homepage we add no additional prefix to the URL route which is

designated by the empty string "". We also import `include` on the second line to concisely add the pages app to our main `urls.py` file.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include # new

urlpatterns = [
    path("admin/", admin.site.urls),
    path("", include("pages.urls")), # new
]
```

Next we create a `pages/urls.py` file with our text editor. This file will import the `HomePageView` and set the path, again, to the empty string "". Note that we provide an optional, but recommended, [named URL](#) of "home" at the end. This will come in handy shortly.

Code

```
# pages/urls.py
from django.urls import path

from .views import HomePageView

urlpatterns = [
    path("", HomePageView.as_view(), name="home"),
]
```

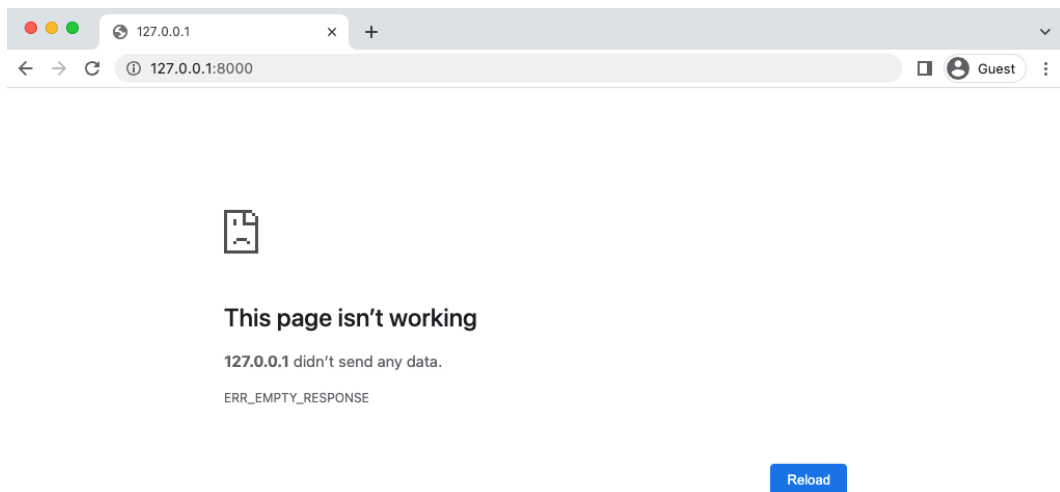
Finally we need a `views.py` file. We can leverage Django's built-in [TemplateView](#) so that the only tweak needed is to specify our desired template, `home.html`.

Code

```
# pages/views.py
from django.views.generic import TemplateView

class HomePageView(TemplateView):
    template_name = "home.html"
```

We're *almost* done. If you navigate to the homepage now at `http://127.0.0.1:8000/` you'll actually see an error. But what's causing it? Since we're running the container in background detached mode—that `-d` flag—we must explicitly check the logs to see console output.

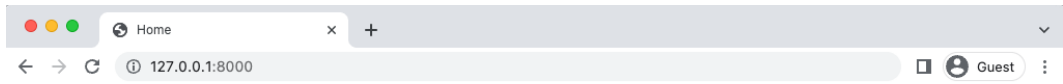
**Django welcome page**

In the shell type `docker-compose logs` which will turn up an error “`ModuleNotFoundError: No module named 'pages.urls'`”. What's happening is that Django does not automatically update the `django_project/settings.py` file for us based on a change. In a non-Docker world stopping and restarting the server does the trick since the settings variables are loaded upfront. We must do the same here which means typing `docker-compose down` and then `docker-compose up -d` to load the new books app in properly.

Shell

```
$ docker-compose down
$ docker-compose up -d
```

Refresh the homepage now and it will work.



This is our home page.

Tests

Time for tests. For our homepage we can use Django's [SimpleTestCase](#) which is a special subset of Django's `TestCase` that is designed for webpages that do not have a model included.

Testing can feel overwhelming at first, but it quickly becomes a bit boring. You'll use the same structure and techniques over and over again. In your text editor, update the existing `pages/tests.py` file. We'll start by testing the template.

Code

```
# pages/tests.py
from django.test import SimpleTestCase
from django.urls import reverse

class HomepageTests(SimpleTestCase):
    def test_url_exists_at_correct_location(self):
        response = self.client.get("/")
        self.assertEqual(response.status_code, 200)

    def test_homepage_url_name(self):
        response = self.client.get(reverse("home"))
        self.assertEqual(response.status_code, 200)
```

At the top we import `SimpleTestCase` as well as `reverse` which is useful for testing our URLs.

Then we create a class called `HomepageTests` that extends `SimpleTestCase` and within it add a method for each unit test.

Note that we're adding `self` as the first argument of each unit test. This is a [Python convention](#) that is worth repeating.

It is best to be overly descriptive with your unit test names but be aware that each method must start with `test` to be run by the Django test suite.

The two tests here both check that the HTTP status code for the homepage equals 200 which means that it exists. It does not yet tell us anything specific about the contents of the page. For `test_url_exists_at_correct_location` we're creating a variable called `response` that accesses the homepage (`/`) and then uses Python's [assertEqual](#) to check that the status code matches 200. A similar pattern exists for `test_homepage_url_name` except that we are calling the URL name of `home` via the `reverse` method. Recall that we added this to the `pages/urls.py` file as a best practice. Even if we change the actual route of this page in the future, we can still refer to it by the same `home` URL name.

To run our tests execute the command prefaced with `docker-compose exec web` so that it runs within Docker itself.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
..
```

```
-----
Ran 4 tests in 0.126s
```

```
OK
Destroying test database for alias 'default'...
```

Why does it say 4 tests when we only created 2? Because we're testing the entire Django project and in the previous chapter under `users/tests.py` we added two tests for the custom user model. If we wanted to only run tests for the pages app we simply append that name onto the command so `docker-compose exec web python manage.py test pages`.

Testing Templates

So far we've tested that the homepage exists, but we should also confirm that it uses the correct template. `SimpleTestCase` comes with a method `assertTemplateUsed` just for this purpose! Let's use it.

Code

```
# pages/tests.py
from django.test import SimpleTestCase
from django.urls import reverse

class HomepageTests(SimpleTestCase):
    def test_url_exists_at_correct_location(self):
        response = self.client.get("/")
        self.assertEqual(response.status_code, 200)

    def test_homepage_url_name(self):
        response = self.client.get(reverse("home"))
        self.assertEqual(response.status_code, 200)

    def test_homepage_template(self): # new
        response = self.client.get("/")
        self.assertTemplateUsed(response, "home.html")
```

We've created a response variable again and then checked that the template `home.html` is used. Let's run the tests again.

Shell

```
$ docker-compose exec web python manage.py test pages
```

```
Creating test database for alias 'default'...
```

```
System check identified no issues (0 silenced).
```

```
...
```

```
-----  
Ran 3 tests in 0.009s
```

```
OK
```

```
Destroying test database for alias 'default'...
```

Did you notice something different in that command? We added the name of our app `pages` so that *only* the tests within that app were run. At this early state it's fine to run all the tests, but in larger projects if you know that you've only added tests within a specific app, it can save time to just run the updated/new tests and not the entire suite.

Testing HTML

Let's now confirm that our homepage has the correct HTML code and also does not have incorrect text. It's always good to test both that tests pass and that tests we expect to fail do, actually, fail!

Code

```
# pages/tests.py
```

```
from django.test import SimpleTestCase
```

```
from django.urls import reverse
```

```
class HomepageTests(SimpleTestCase):
```

```
    def test_url_exists_at_correct_location(self):
```

```
        response = self.client.get("/")
```

```
        self.assertEqual(response.status_code, 200)
```

```
    def test_homepage_url_name(self):
```

```
        response = self.client.get(reverse("home"))
```

```
        self.assertEqual(response.status_code, 200)
```

```
    def test_homepage_template(self):
```

```
response = self.client.get("/")
self.assertTemplateUsed(response, "home.html")

def test_homepage_contains_correct_html(self): # new
    response = self.client.get("/")
    self.assertContains(response, "home page")

def test_homepage_does_not_contain_incorrect_html(self): # new
    response = self.client.get("/")
    self.assertNotContains(response, "Hi there! I should not be on the page.")
```

Run the tests again.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
```

```
.....
```

```
-----
Ran 7 tests in 0.279s
```

OK

```
Destroying test database for alias 'default'...
```

setUp()

Have you noticed that we seem to be repeating ourself with these unit tests? For each one we are loading a response variable which seems wasteful and prone to errors. It'd be better to stick to something more DRY (Don't Repeat Yourself) such as doing this once at the top of the tests with a function called `setUp` that loads the response into a response variable.

Our current `test_homepage_url` test is now redundant since `setUp` first runs reverse on our named template "home" so we can remove that test.

Code

```
# pages/tests.py
from django.test import SimpleTestCase
from django.urls import reverse

class HomepageTests(SimpleTestCase):
    def setUp(self): # new
        url = reverse("home")
        self.response = self.client.get(url)

    def test_url_exists_at_correct_location(self):
        self.assertEqual(self.response.status_code, 200)

    def test_homepage_template(self):
        self.assertTemplateUsed(self.response, "home.html")

    def test_homepage_contains_correct_html(self):
        self.assertContains(self.response, "home page")

    def test_homepage_does_not_contain_incorrect_html(self):
        self.assertNotContains(self.response, "Hi there! I should not be on the page.")
```

Now run the tests again. Because `setUp` is a helper method and does not start with `test` it will not be considered a unit test in the final tally. So only 6 total tests will run.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
....
```

```
-----
Ran 6 tests in 0.126s
```

```
OK
Destroying test database for alias 'default'...
```

Resolve

A final views check we can do is that our `HomePageView` “resolves” a given URL path. Django contains the utility function `resolve` for just this purpose. We will need to import both `resolve` as well as the `HomePageView` at the top of the file.

Our actual test, `test_homepage_url_resolves_homepageview`, checks that the name of the view used to resolve / matches `HomePageView`.

Code

```
# pages/tests.py
from django.test import SimpleTestCase
from django.urls import reverse, resolve # new

from .views import HomePageView # new

class HomepageTests(SimpleTestCase):
    def setUp(self):
        url = reverse("home")
        self.response = self.client.get(url)

    def test_url_exists_at_correct_location(self):
        self.assertEqual(self.response.status_code, 200)

    def test_homepage_template(self):
        self.assertTemplateUsed(self.response, "home.html")

    def test_homepage_contains_correct_html(self):
        self.assertContains(self.response, "home page")

    def test_homepage_does_not_contain_incorrect_html(self):
        self.assertNotContains(self.response, "Hi there! I should not be on the page.")

    def test_homepage_url_resolves_homepageview(self): # new
        view = resolve("/")
        self.assertEqual(view.func.__name__, HomePageView.as_view().__name__)
```

Phew. That’s our last test. Let’s confirm that everything passes.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
.....
-----
Ran 7 tests in 0.126s
```

```
OK
Destroying test database for alias 'default'...
```

Git

Time to add our new changes to source control with Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch5'
```

You can compare with the [official source code on Github](#) for this chapter.

Conclusion

We have configured our templates and added the first page to our project, a static homepage. We also added tests which should *always* be included with new code changes. Some developers prefer a method called Test-Driven Development where they write the tests first and then the code. Personally I prefer to write the tests *immediately after* which is what we'll do here.

Both approaches work, the key thing is to be rigorous with your testing. Django projects quickly grow in size where it's impossible to remember all the working pieces in your head. And if you are working on a team, it is a nightmare to work on an untested codebase. Who knows what will break?

In the next chapter we'll add user registration to our project: log in, log out, and sign up.

Chapter 6: User Registration

User registration is a core feature in any dynamic website. And it will be in our Bookstore project, too. In this chapter we will implement log in, log out, and sign up functionality. The first two are relatively straightforward since Django provides us with the necessary views and urls for them, however sign up is more challenging since there is no built-in solution.

Auth App

Let's begin by implementing log in and log out using Django's own [auth](#) app. Django provides us with the necessary views and urls which means we only need to update a template for things to work. This saves us a lot of time as developers and it ensures that we don't make a mistake since the underlying code has already been tested and used by millions of developers.

However this simplicity comes at the cost of feeling “magical” to Django newcomers. We covered some of these steps previously in my book, [Django for Beginners](#), but we did not slow down and look at the underlying source code. That book demonstrated “how” to implement user registration properly but did not do a deep dive into the “why.”

Since this is a more advanced book, we will dive deeper to understand the underlying source code. The approach here can also be used to explore any other built-in Django functionality on your own.

The first thing we need to do is make sure the auth app is included in our `INSTALLED_APPS` setting. We have added our own apps here previously, but have you ever taken a close look at the built-in apps Django adds automatically for us? Most likely the answer is no. Let's do that now!

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth", # Yoohoo!!!!
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig",
]
```

There are, in fact, 6 apps already there that Django provides for us which power the site. The first is `admin` and the second is `auth`. This is how we know the `auth` app is already present in our Django project.

When we earlier ran the `migrate` command for the first time all of these apps were linked together in the initial database. And remember that we used the `AUTH_USER_MODEL` setting to tell Django to use our custom user model, not the default `User` model here. This is why we had to wait until that configuration was complete before running `migrate` for the first time.

Auth URLs and Views

To use Django's built-in `auth` app we must explicitly add it to our `config/urls.py` file. The easiest approach is to use `accounts/` as the prefix since that is commonly used in the Django community. Make the one line change below. Note that as our `urls.py` file grows in length, adding comments for each type of URL—`admin`, `user management`, `local apps`, etc.—helps with readability.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("admin/", admin.site.urls),
    # User management
    path("accounts/", include("django.contrib.auth.urls")), # new
    # Local apps
    path("", include("pages.urls")),
]
```

What's included in the auth app? A lot it turns out. First off, there are a number of associated urls.

Code

```
accounts/login/ [name="login"]
accounts/logout/ [name="logout"]
accounts/password_change/ [name="password_change"]
accounts/password_change/done/ [name="password_change_done"]
accounts/password_reset/ [name="password_reset"]
accounts/password_reset/done/ [name="password_reset_done"]
accounts/reset/<uidb64>/<token>/ [name="password_reset_confirm"]
accounts/reset/done/ [name="password_reset_complete"]
```

How did I know that? Two ways. The first is the [official auth docs](#) tell us so! But a second, deeper approach is to look at the Django source code which is [available on Github](#). If we navigate or search around we'll find our way to the [auth app itself](#). And within *that* we can find the `urls.py` file [at this link](#) which shows the complete source code.

It takes practice to understand the Django source code, but it is well worth the time.

Homepage

What's next? Let's update our existing homepage so that it will notify us if a user is already logged in or not which currently can only happen via the admin.

Here is the new code for the `templates/home.html` file. It uses the Django templating engine's `if/else` tags for basic logic.

Code

```
<!-- templates/home.html -->
{% extends "_base.html" %}

{% block title %}Home{% endblock title %}

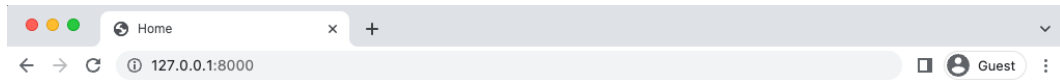
{% block content %}
  <h1>This is our home page.</h1>
  {% if user.is_authenticated %}
    <p>Hi {{ user.email }}!</p>
  {% else %}
    <p>You are not logged in</p>
    <a href="{% url 'login' %}">Log In</a>
  {% endif %}
{% endblock content %}
```

If the user is logged in (authenticated), we display a greeting that says “Hi” and includes their email address. These are both `variables` which we can use with Django’s template engine via double opening `{{` and closing `}}` brackets.

The default `User` contains numerous fields including `is_authenticated` and `email` which are referenced here.

And the `logout` and `login` are URL names. The `url` template tag means if we specify the URL name the link will automatically refer to that URL path. For example, in the previous chapter we set the URL name for the homepage to `home`, which means a homepage link would take the format of `{% url 'home' %}`. More on this shortly.

If you look at the homepage now at `http://127.0.0.1:8000/` it will likely show the email address of your superuser account since we used it previously to log in.

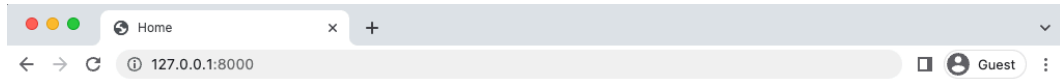


This is our home page.

Hi will@wsvincent.com!

Homepage with greeting

In the admin over at <http://127.0.0.1:8000/admin/>, if you click on the “Log out” button in the upper right corner we can log out of the admin and by extension the Django project. Return to the homepage at <http://127.0.0.1:8000/> and refresh the page.



This is our home page.

You are not logged in

[Log In](#)

Admin logout link

Django Source Code

You might have been able to piece together these steps on your own from reading [the official docs](#). But the deeper—and better—approach is to learn how to read the Django source code on your own.

One question is, how was the `user` and its related variables magically available in our template? The answer is that Django has a concept called the [template context](#) which means each template is loaded with data from the corresponding `views.py` file. We can use `user` within template tags to access User attributes. In other words, Django just gives this to us automatically.

So to check if a user is logged in or not, we access `user` and then can use the boolean [is_authenticated](#) attribute. If a user is logged in, it will return `True` and we can do things like display the user’s email. Or if no user is logged in, the result will be `False`.

Moving on we have the URL name `login`. Where did that come from? The answer, of course, is

from Django itself! Let's unpack the code snippet `{% url 'login' %}` piece by piece.

First up we're using the [url template tag](#) which takes as its first argument a [named URL pattern](#). That's the optional name section we add as a best practice to all our URL paths. Therefore there must be a 'login' name attached to the URL used by Django for log ins, right!

There are two ways we could have known this. In other words, if I hadn't just told you that we wanted to use `{% url 'login' %}`, how could you have figured it out?

First look at the [official documentation](#). Personally I often use the search feature so I would have typed in something like “login” and then clicked around until I found a description of log in. The one we want is actually called [authentication views](#) and lists the corresponding URL patterns for us.

Code

```
accounts/login/ [name="login"]
accounts/logout/ [name="logout"]
accounts/password_change/ [name="password_change"]
accounts/password_change/done/ [name="password_change_done"]
accounts/password_reset/ [name="password_reset"]
accounts/password_reset/done/ [name="password_reset_done"]
accounts/reset/<uidb64>/<token>/ [name="password_reset_confirm"]
accounts/reset/done/ [name="password_reset_complete"]
```

This tells us at the path `accounts/login/` is where “login” is located and its name is 'login'. A little confusing at first, but here is the info we need.

Going a step deeper to phase two, we can investigate the underlying Django source code to see “logout” in action. If you perform a search [over on Github](#) you'll eventually find the [auth app itself](#). Ok, now let's start by investigating the `urls.py` file. [Here is the link](#) to the complete code:

Code

```
# django/contrib/auth/urls.py
from django.contrib.auth import views
from django.urls import path

urlpatterns = [
    path('login/', views.LoginView.as_view(), name='login'),
    path('logout/', views.LogoutView.as_view(), name='logout'),

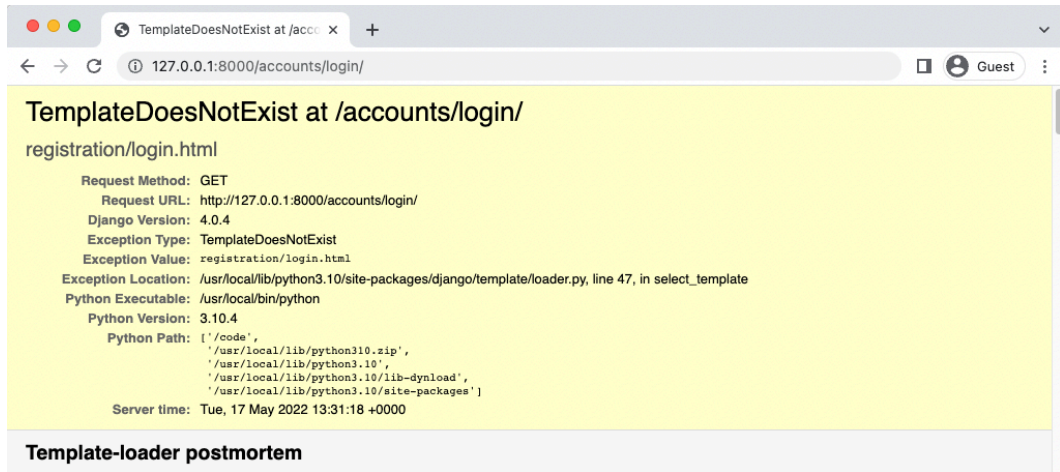
    path('password_change/', views.PasswordChangeView.as_view(),
         name='password_change'),
    path('password_change/done/', views.PasswordChangeDoneView.as_view(),
         name='password_change_done'),
    path('password_reset/', views.PasswordResetView.as_view(),
         name='password_reset'),
    path('password_reset/done/', views.PasswordResetDoneView.as_view(),
         name='password_reset_done'),
    path('reset/<uidb64>/<token>/', views.PasswordResetConfirmView.as_view(),
         name='password_reset_confirm'),
    path('reset/done/', views.PasswordResetCompleteView.as_view(),
         name='password_reset_complete'),
]
```

Here is the underlying code Django uses itself for the auth app. I hope you can see that the “logout” route is not magic. It’s right there in plain sight, it uses the view `LogoutView` and has the URL name `'logout'`. Not magic at all! Just a little challenging to find the first time.

This three-step process is a great way to learn: either remember the Django shortcut, look it up in the docs, or on occasion dive into the source code and truly understand where all this goodness comes from.

Log In

Back on our basic homepage, click on the “Log In” link and... it results in an error!



TemplateDoesNotExist error

Django is throwing a `TemplateDoesNotExist` error at us. Specifically, it seems to expect a log in template at `registration/login.html`. In addition to Django telling us this, we can look in the [documentation](#) and see that the desired `template_name` has that location.

But let's really be sure and check the source code so we can remove any perceived magic here. After all, it's just Django.

Back in the `auth/views.py` file we can see on line 47 for `LoginView` that the `template_name` is `'registration/login.html'`. So if we wanted to change the default location we could, but it would mean overriding `LoginView` which seems like overkill. Let's just use what Django gives us here.

Create a new `registration` folder within the existing `templates` directory.

Shell

```
$ mkdir templates/registration
```

Then in your text editor create a `login.html` file within the `templates/registration` directory. The actual code is as follows. We extend our base template, add a title, and then specify that we want to use a form that will “post” or send the data.

Code

```
<!-- templates/registration/login.html -->
{% extends "_base.html" %}

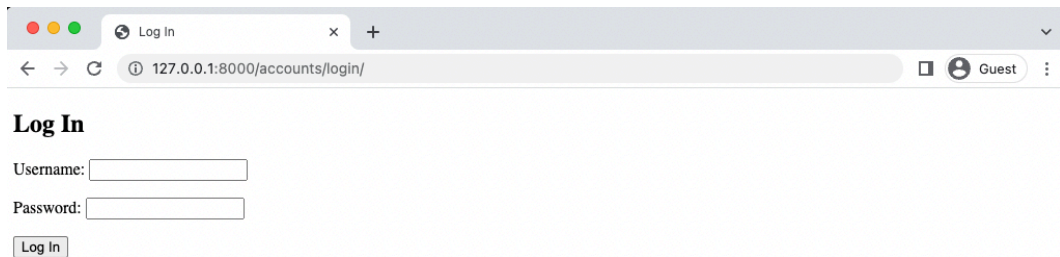
{% block title %}Log In{% endblock title %}

{% block content %}
    <h2>Log In</h2>
    <form method="post">
        {% csrf_token %}
        {{ form.as_p }}
        <button type="submit">Log In</button>
    </form>
{% endblock content %}
```

You should **always** add [CSRF protection](#) on any submittable form. Otherwise a malicious website can change the link and attack the site and the user. Django has CSRF middleware to handle this for us; all we need to do is add `{% csrf_token %}` tags at the start of the form.

Next we can control the look of the form contents. For now we'll use `as_p()` so that each form field is displayed within a paragraph `p` tag.

With that explanation out of the way, let's check if our new template is working correctly. Refresh the web page at `http://127.0.0.1:8000/accounts/login/`.



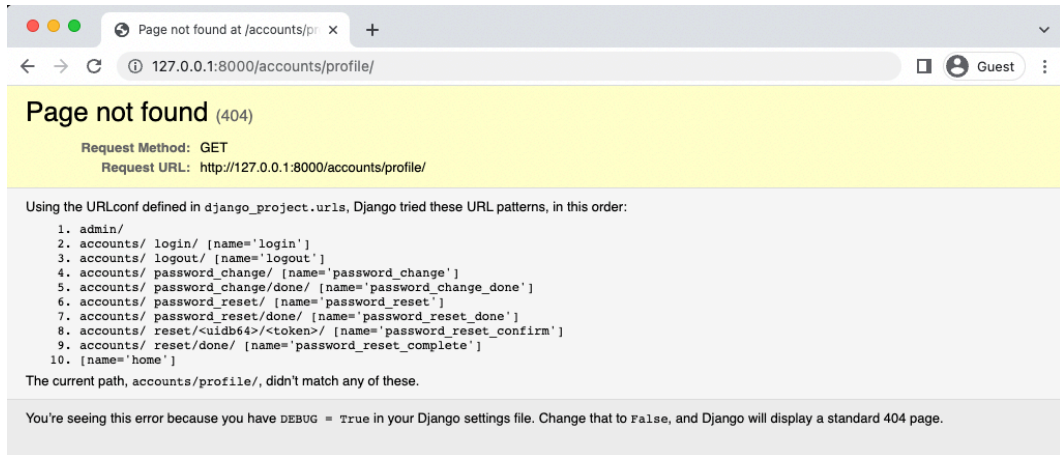
The screenshot shows a web browser window with the title "Log In". The address bar displays the URL "127.0.0.1:8000/accounts/login/". The page content includes a heading "Log In" followed by two form fields: "Username:" and "Password:". Below these fields is a button labeled "Log In".

Log in page

And there is our page! Lovely. You can navigate back to the homepage and confirm that the “Log In” link works, too, if you like. As a final step, go ahead and try to log in with your superuser account on the log in page.

Redirects

Did you notice I said “try” in that last sentence? If you click on the “Log In” link it brings up a Page not found (404) error.



Page not found error

Django has redirected us to `127.0.0.1:8000/accounts/profile/` yet no such page exists. Now why would Django do this? Well, if you think about it, how does Django know where we want to redirect the user after log in? Maybe it's the homepage. But maybe it's a user profile page. Or any number of options.

The final piece of the log in puzzle is to set the proper configuration for `LOGIN_REDIRECT_URL` because by default it redirects to `accounts/profile`.

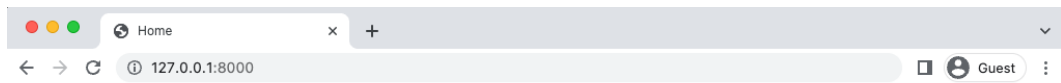
Fortunately, this is a quick fix. We'll send the user to our homepage. And since we specified a URL name of `home` that's all we need to redirect logged in users to the homepage.

At the bottom of the `django_project/settings.py` file add this one line.

Code

```
# django_project/settings.py
LOGIN_REDIRECT_URL = "home" # new
```

Attempt to log in again at <http://127.0.0.1:8000/accounts/login/>. Upon success it redirects the user to the homepage greeting the superuser account you just logged in with!



This is our home page.

Hi will@wsvincent.com!

[Homepage logged out](#)

Log Out

Now let's add a log out option to our homepage since only a superuser will have access to the admin. How do we do this?

If you look at the auth views above we can see that logout uses `LogoutView`, which we could explore in the source code, and has a URL name of `logout`. That means we can refer to it with a template tag as just `logout`.

But we can set this ourselves, if desired, using `LOGOUT_REDIRECT_URL` which can be added to the bottom of our `django_project/settings.py` file. Let's do that so a logged out user is redirected to the homepage.

Code

```
# django_project/settings.py
LOGIN_REDIRECT_URL = "home"
LOGOUT_REDIRECT_URL = "home" # new
```

Then add the logout link to `templates/home.html`.

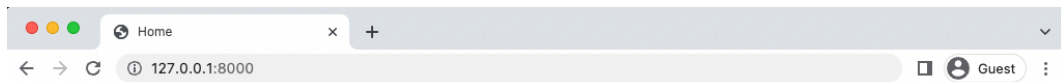
Code

```
<!-- templates/home.html -->
{% extends "_base.html" %}

{% block title %}Home{% endblock title %}

{% block content %}
  <h1>This is our home page.</h1>
  {% if user.is_authenticated %}
    <p>Hi {{ user.email }}!</p>
    <p><a href="{% url 'logout' %}">Log Out</a></p>
  {% else %}
    <p>You are not logged in</p>
    <a href="{% url 'login' %}">Log In</a>
  {% endif %}
{% endblock content %}
```

Refresh the homepage at <http://127.0.0.1:8000/> and the “Log out” link is now visible.



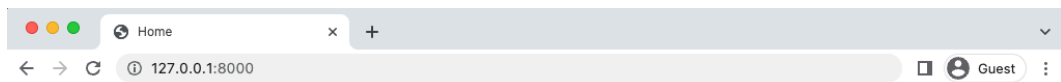
This is our home page.

Hi will@wsvincent.com!

[Log Out](#)

Homepage with logout link

If you click on it you will be logged out and redirected to the homepage, which has the “Log In” link visible.



This is our home page.

You are not logged in

[Log In](#)

Homepage with login link

Sign Up

Implementing a sign up page for user registration is completely up to us. We'll go through the standard steps for any new page:

- create an app-level `accounts/urls.py` file
- update the project-level `django_project/urls.py` to point to the `accounts` app
- add a view called `SignupPageView`
- create a `signup.html` template file
- update `home.html` to display the sign up page

A common question is: what's the right order for implementing these steps? Honestly, it doesn't matter since we need *all* of them for the sign up page to work properly. I know it would be more comforting if there was a prescribed order but each is a puzzle piece that fits together in their entirety. That said, I generally like to start with `urls`, then switch to `views`, and finally `templates` but it's a matter of personal preference.

To start use your text editor to create an `accounts/urls.py` file. Up to this point the `accounts` app has only contained our `CustomUser` in the `models.py` file; we haven't configured any routes or views.

The URL path for the sign up page will take a view called `SignupPageView` (which we'll create next), at the route `signup/`, and have a name of `signup` which we can later use to refer to the page with a `url` template tag. The existing url names for `login` and `signup` are written within the built-in Django app file `django/contrib/auth/urls.py` we saw above.

Code

```
# accounts/urls.py
from django.urls import path

from .views import SignupPageView

urlpatterns = [
    path("signup/", SignupPageView.as_view(), name="signup"),
]
```

Next update the `django_project/urls.py` file to include the accounts app. We can create any route we like but it's common to use the same `accounts/` one used by the default auth app. Note that it's important to include the path for `accounts.urls` **below**: URL paths are loaded top-to-bottom so this ensures that any built-in auth app URL paths will be loaded first.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("admin/", admin.site.urls),
    # User management
    path("accounts/", include("django.contrib.auth.urls")),
    # Local apps
    path("accounts/", include("accounts.urls")), # new
    path("", include("pages.urls")),
]
```

Now create the view `SignupPageView`. It references the `CustomUserCreationForm` and has a `success_url` that points to the login page, meaning after the form is submitted the user will be redirected there. The `template_name` will be `signup.html`.

Code

```
# accounts/views.py
from django.urls import reverse_lazy
from django.views import generic

from .forms import CustomUserCreationForm

class SignupPageView(generic.CreateView):
    form_class = CustomUserCreationForm
    success_url = reverse_lazy("login")
    template_name = "registration/signup.html"
```

As a final step create a file called `templates/registration/signup.html` which will contain code basically identical to the log in page.

Code

```
<!-- templates/registration/signup.html -->
{% extends "_base.html" %}

{% block title %}Sign Up{% endblock title %}

{% block content %}
    <h2>Sign Up</h2>
    <form method="post">
        {% csrf_token %}
        {{ form.as_p }}
        <button type="submit">Sign Up</button>
    </form>
{% endblock content %}
```

As a final step we can add a line for “Sign Up” to our `home.html` template right below the link for “Log In”. This is a one-line change.

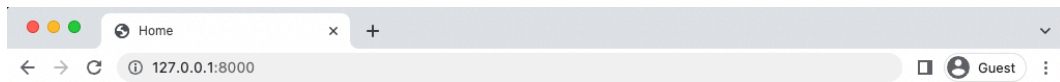
Code

```
<!-- templates/home.html -->
{% extends "_base.html" %}

{% block title %}Home{% endblock title %}

{% block content %}
  <h1>This is our home page.</h1>
  {% if user.is_authenticated %}
    <p>Hi {{ user.email }}!</p>
    <p><a href="{% url 'logout' %}">Log Out</a></p>
  {% else %}
    <p>You are not logged in</p>
    <a href="{% url 'login' %}">Log In</a>
    <a href="{% url 'signup' %}">Sign Up</a>
  {% endif %}
{% endblock content %}
```

All done! Reload the homepage to see our work.



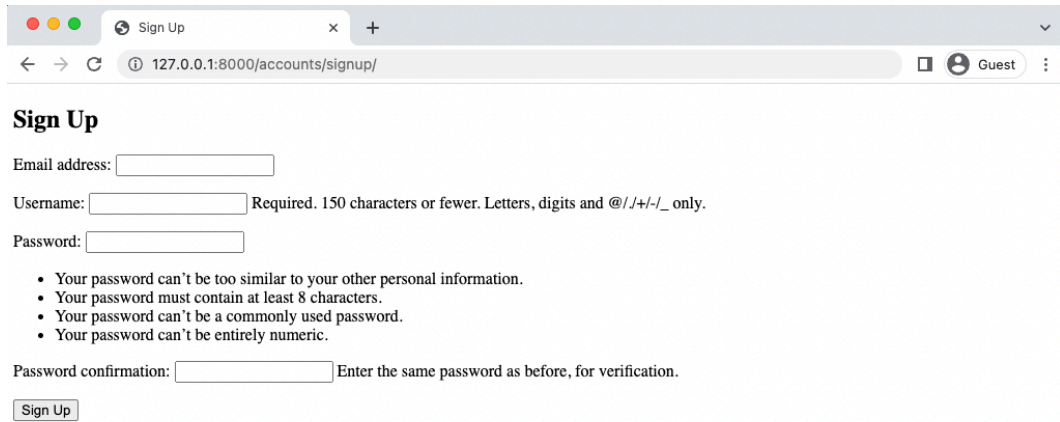
This is our home page.

You are not logged in

[Log In](#) [Sign Up](#)

Homepage with Signup

The “Sign Up” link now redirects to the webpage <http://127.0.0.1:8000/accounts/signup/>.



Sign Up

Email address:

Username: Required. 150 characters or fewer. Letters, digits and @/./+/_ only.

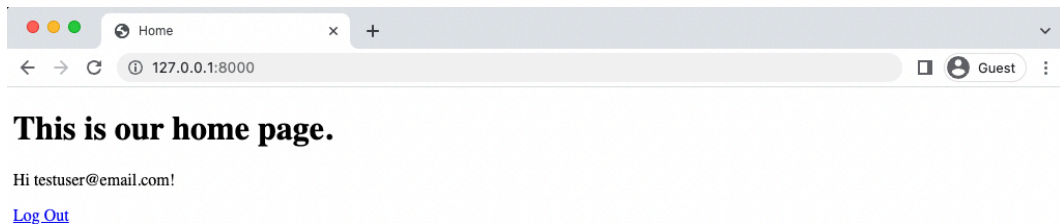
Password:

- Your password can't be too similar to your other personal information.
- Your password must contain at least 8 characters.
- Your password can't be a commonly used password.
- Your password can't be entirely numeric.

Password confirmation: Enter the same password as before, for verification.

Signup page

Create a new user with the email address `testuser@email.com`, username of `testuser`, and `testpass123` for the password. Upon submission it will redirect us to the Log In page. Log in with the new account and it redirects to the homepage with a personalized greeting.



This is our home page.

Hi testuser@email.com!

[Log Out](#)

Homepage with testuser greeting

Tests

For tests we do *not* need to test log in and log out features since those are built into Django and already have tests. We *do* need to test our sign up functionality though!

Let's start by creating a `setUpTestClass` method that loads our page. Then we'll populate `test_signup_template` with tests for the status code, template used, and both included and excluded text similarly to how we did it in the last chapter for the homepage.

In your text editor, update the `accounts/tests.py` file with these changes.

Code

```
# accounts/tests.py
from django.contrib.auth import get_user_model
from django.test import TestCase
from django.urls import reverse # new

class CustomUserTests(TestCase):
    ...

class SignUpPageTests(TestCase): # new
    def setUp(self):
        url = reverse("signup")
        self.response = self.client.get(url)

    def test_signup_template(self):
        self.assertEqual(self.response.status_code, 200)
        self.assertTemplateUsed(self.response, "registration/signup.html")
        self.assertContains(self.response, "Sign Up")
        self.assertNotContains(self.response, "Hi there! I should not be on the page.")
```

Then run our tests.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
```

```
.....
```

```
-----
Ran 8 tests in 0.148s
```

```
OK
```

```
Destroying test database for alias 'default'...
```

Next we can test that our CustomUserCreationForm is being used and that the page resolves to SignUpPageView.

Code

```
# accounts/tests.py
from django.contrib.auth import get_user_model
from django.test import TestCase
from django.urls import reverse, resolve # new

from .forms import CustomUserCreationForm # new
from .views import SignupPageView # new

class CustomUserTests(TestCase):
    ...

class SignupPageTests(TestCase): # new
    def setUp(self):
        url = reverse("signup")
        self.response = self.client.get(url)

    def test_signup_template(self):
        self.assertEqual(self.response.status_code, 200)
        self.assertTemplateUsed(self.response, "registration/signup.html")
        self.assertContains(self.response, "Sign Up")
        self.assertNotContains(self.response, "Hi there! I should not be on the page.")

    def test_signup_form(self): # new
        form = self.response.context.get("form")
        self.assertIsInstance(form, CustomUserCreationForm)
        self.assertContains(self.response, "csrfmiddlewaretoken")

    def test_signup_view(self): # new
        view = resolve("/accounts/signup/")
        self.assertEqual(view.func.__name__, SignupPageView.as_view().__name__)
```

Run our tests again.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
.....
```

```
-----
Ran 10 tests in 0.155s
```

```
OK
Destroying test database for alias 'default'...
```

All done.

Git

As ever make sure to save our work by adding changes into Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch6'
```

The official source code is [located on Github](#) if you want to compare your code.

Conclusion

Our Bookstore project is not the most beautiful site in the world, but it is very functional at this point. In the next chapter we'll configure our static assets and add Bootstrap for improved styling.

Chapter 7: Static Assets

Static assets like CSS, JavaScript, and images are a core component of any modern web application. Django provides us with a large degree of flexibility around their configuration and storage which can be confusing to newcomers but in practice the pattern is almost identical for all projects. In this chapter we'll configure our initial static assets and add [Bootstrap](#) for improved styling.

Local Development

For local development the Django web server automatically serves static files and minimal configuration is required. Static files can be placed in an app-level directory called `static` so we could, for example, create a new directory within the `pages` app called `pages/static/`.

However most projects reuse static assets across multiple apps. Our bookstore app certainly will! So a more common approach is to create a base-level directory `static` folder and place all static files within there. This is easier to reason about as a developer.

From the command line create a new `static` folder along with new subdirectories for CSS, JavaScript, and images.

Shell

```
$ mkdir static
$ mkdir static/css
$ mkdir static/js
$ mkdir static/images
```

Your Django project should have the following structure at this point:

Project Structure

```
├── Dockerfile
├── accounts
│   └── ...
├── db.sqlite3
├── django_project
│   └── ...
├── docker-compose.yml
├── manage.py
├── pages
│   └── ...
├── requirements.txt
├── static
│   ├── css
│   ├── images
│   └── js
├── templates
└── ...
```

It's important to be aware that Git, by default, will not track directories that are empty. Thus when we eventually push our code to both GitHub and Heroku these empty directories will not appear which can cause problems in deployment when `collectstatic` is run. To avoid this we will add an empty file to each directory now.

In your text editor create the following three files:

- `static/css/base.css`
- `static/js/base.js`
- `static/images/.keep`

STATICFILES_DIRS

At the bottom of the `django_project/settings.py` file is a section on “Static files” which has already set `STATIC_URL` to `"static/"`. This is the URL used when referring to static files. It means that for local usage all static files are located at `http://127.0.0.1:8000/static/`.

The built-in `staticfiles` app that ships with Django—you can see it in the `INSTALLED_APPS` section of `django_project/settings.py`—ships with a quick and dirty helper view that will

serve files locally for development. It will automatically look for a `static` directory within each application.

Many static files are not app-specific though and are intended to be used project-wide. That's why creating a base directory `static` folder, as we did above, is a common practice. We just need to provide a list of additional directories for Django to look in, which is the job of `STATICFILES_DIRS`. Since this is a list we must place brackets, `[]`, around it in standard Python syntax.

Here is what the updated `django_project/settings.py` file should look like.

Code

```
# django_project/settings.py
STATIC_URL = "/static/"
STATICFILES_DIRS = [BASE_DIR / "static"] # new
```

CSS

We'll update `base.css` now and keep things simple by having our `h1` headline be red. The point is to show how CSS can be added to our project, not to delve too deeply into CSS itself.

Code

```
/* static/css/base.css */
h1 {
    color: red;
}
```

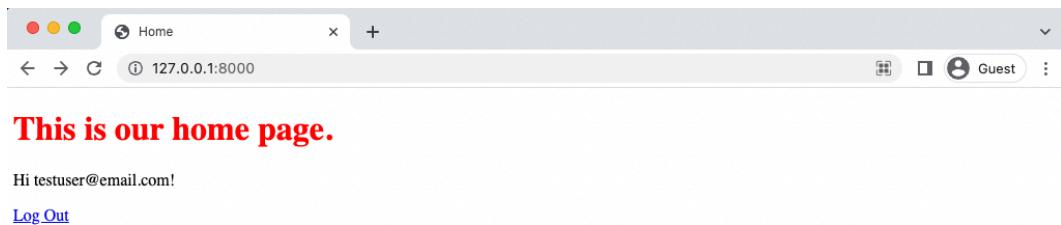
If you refresh the homepage now you'll see that nothing has changed. That's because static assets must be explicitly loaded into templates! To do this we must add `{% load static %}` at the top of `_base.html` and then use the `static` template tag to reference our `base.css` file. Even though this file is located at `static/css/base.css` we can refer to it as `css/base.css` because the `static` tag automatically looks within the `/static/` directory specified in `STATIC_URL`.

Here is what the updated `templates/_base.html` file should look like.

Code

```
<!-- templates/_base.html -->
{% load static %}
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <title>{% block title %}Bookstore{% endblock %}</title>
  <!-- CSS -->
  <link rel="stylesheet" href="{% static 'css/base.css' %}">
</head>
...
```

Refresh the homepage to see our work.

**Homepage with red text**

There's our CSS in action! If instead you see an error screen saying Invalid block tag on line 7: 'static'. Did you forget to register or load this tag? then you forgot to include the line `{% load static %}` at the top of the file. I do this all the time myself.

Images

How about an image? You can download the book cover for *Django for Professionals* at [this link](#). Save it into the directory `books/static/images` as `dfp.png`.

To display it on the homepage, update `templates/home.html` by adding the `{% load static %}` tag at the top. Then under the `<h1>` tags add an `` class that also uses `static` to display the new cover.

Code

```
<!-- templates/home.html -->
{% extends "_base.html" %}
{% load static %}

{% block title %}Home{% endblock title %}

{% block content %}
  <h1>This is our home page.</h1>
  
  {% if user.is_authenticated %}
    <p>Hi {{ user.email }}!</p>
    <p><a href="{% url 'logout' %}">Log Out</a></p>
  {% else %}
    <p>You are not logged in</p>
    <p><a href="{% url 'login' %}">Log In</a> |
      <a href="{% url 'signup' %}">Sign Up</a></p>
  {% endif %}
{% endblock content %}
```

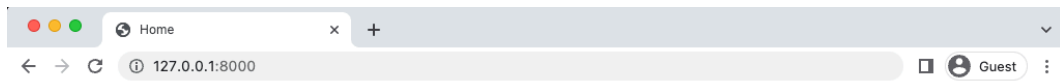
Refreshing the homepage you'll see the raw file is quite large! Let's control that with some additional CSS.

Code

```
/* static/css/base.css */
h1 {
  color: red;
}

.bookcover {
  height: 300px;
  width: auto;
}
```

Now refresh the homepage and the book cover image fits nicely.



This is our home page.



Hi testuser@email.com!

[Log Out](#)

Homepage with Book Cover

If you don't see the change you might need to perform a “hard refresh” to bypass your web browser's local cache. Modern web browsers automatically keep local copies of pages, images, and other content already visited to speed up performance. On occasion this automatic caching results in a browser showing out-of-date content. The solution is force a re-download of a web page's content, also known as a “hard refresh” or “cache refresh”. On Windows this can be done by holding `Ctrl+F5`; on macOS hold `Cmd+Shift+R`.

JavaScript

We already have a `base.js` file we can use to add JavaScript to our project. Often I put a tracking code of some kind here, such as for Google Analytics, but for demonstration purposes we'll add a `console.log` statement so we can confirm the JavaScript loaded correctly.

Code

```
// static/js/base.js
console.log("JavaScript here!")
```

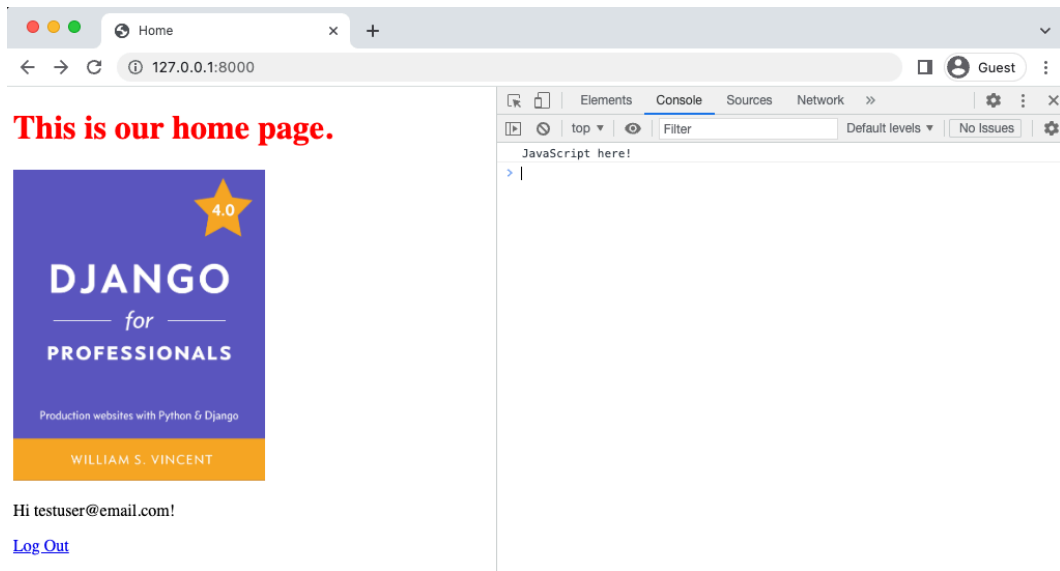
Now add it to our `_base.html` template. JavaScript should be added at the bottom of the file so it is loaded last, after the HTML, CSS, and other assets that appear first on the screen when rendered in the web browser. This gives the appearance of the complete webpage loading faster.

Code

```
<!-- templates/_base.html -->
{% load static %}
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <title>{% block title %}Bookstore{% endblock title %}</title>
  <!-- CSS -->
  <link rel="stylesheet" href="{% static 'css/base.css' %}">
</head>
<body>
  <div class="container">
    {% block content %}
    {% endblock content %}
  </div>
  <!-- JavaScript -->
  <script src="{% static 'js/base.js' %}"></script>
</body>
</html>
```

In your web browser, make the JavaScript console available. This involves opening up Developer Tools and making sure you're on the "Console" section. On Chrome which is being used for the images in this book, go to View in the top menu, then Developer -> Developer Tools which will open a sidebar. Make sure Console is selected from the options.

If you refresh the page, you should see the following:



Homepage JavaScript console view

Production

Local development is designed to keep things nice and easy for static files. Whether they are located in an individual app or in a base-level directory, the Django server will display everything for us. But this approach is not very efficient since each resource must be individually requested and served from each location. In a production environment it is far more efficient to combine all static files into one location and serve that in a single, larger HTTP request.

Django comes with a built-in management command, `collectstatic`, that does this for us. But we need to configure two more settings in our `django_project/settings.py` file before `collectstatic` will work properly.

The first setting is `STATIC_ROOT` which sets the absolute location of these collected files. This can be named anything you like but is typically called “staticfiles”. When `collectstatic` is run locally it will combine all available static files as defined by `STATICFILES_DIRS` and place them within a directory as defined by `STATIC_ROOT`. We are setting `STATIC_ROOT` to be in the base directory with the name `staticfiles`. Here is what the code looks like:

Code

```
# django_project/settings.py
STATIC_URL = "/static/"
STATICFILES_DIRS = [BASE_DIR / "static"]
STATIC_ROOT = BASE_DIR / "staticfiles" # new
```

The second setting is `STATICFILES_STORAGE`, which is the file storage engine used when collecting static files with the `collectstatic` command. By default, it is implicitly set to `django.contrib.staticfiles.storage.StaticFilesStorage`. Let's make that explicit for now in our `django_project/settings.py` file.

Code

```
# django_project/settings.py
STATIC_URL = "/static/"
STATICFILES_DIRS = [BASE_DIR / "static"]
STATIC_ROOT = BASE_DIR / "staticfiles"
STATICFILES_STORAGE = "django.contrib.staticfiles.storage.StaticFilesStorage" # new
```

There is actually one more default static files setting available, `STATICFILES_FINDERS`, but it is typically not customized so we will leave it out of the `django_project/settings.py` file at this time.

Now we can run the command `python manage.py collectstatic` which will combine all static files into a new `staticfiles` directory.

Shell

```
(.venv) $ docker-compose exec web python manage.py collectstatic
131 static files copied to '/code/staticfiles'.
```

If you look within your text editor, there is now a `staticfiles` directory with four subdirectories: `admin`, `css`, `images`, and `js`. The first one is the static assets of the Django `admin` app and the other three we specified. That's why there are 122 files copied over.

Bootstrap

Writing custom CSS for your website is a worthy goal and something I advise all software developers, even back-end ones, to try at some point. But practically speaking there is a reason front-end frameworks like [Bootstrap](#) exist: they save you a ton of time when starting a new project. Unless you have a dedicated designer to collaborate with, stick with a framework for the early iterations of your website.

Bootstrap can be installed locally or used via a CDN. The latter is a far simpler approach so we will adopt it in this book. Instructions [can be found here](#) to deliver a cached version of Bootstrap's compiled CSS and JS to our project.

Note that the full links for Bootstrap are not included. You should copy and paste them in from the Bootstrap website to be accurate. They are referenced here as Bootstrap CSS and Bootstrap JavaScript.

Code

```
<!-- templates/_base.html -->
{% load static %}
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <title>{% block title %}Bookstore{% endblock %}</title>
  <!-- Bootstrap CSS -->
  <link href="https://cdn.jsdelivr.net/npm/bootstrap@5.1.3/dist/css/bootstrap.min.css..."
>
  <!-- CSS -->
  <link rel="stylesheet" href="{% static 'css/base.css' %}">
</head>
<body>
  <div class="container">
    {% block content %}
    {% endblock content %}
  </div>
  <!-- Bootstrap JavaScript -->
  <script src="https://cdn.jsdelivr.net/npm/bootstrap@5.1.3/dist/js/bootstrap.bundle.min.\
js..."></script>
  <!-- JavaScript -->
  <script src="{% static 'js/base.js' %}"></script>
```



```
</body>
</html>
```

Note that order matters here for both the CSS and JavaScript. The file will be loaded top-to-bottom so our `base.css` file comes *after* the Bootstrap CSS. This means our custom `h1` style will override the Bootstrap default. At the bottom of the file we also place our `base.js` file after the Bootstrap JavaScript file.

Now it's time to actually use Bootstrap. We'll start by adding a fixed navbar to the `_base.html` file at the top of the `<body>` section.

Code

```
<!-- templates/_base.html -->
...
<body>
  <nav class="navbar navbar-expand-md navbar-dark fixed-top bg-dark">
    <div class="container-fluid">
      <a class="navbar-brand" href="#">Bookstore</a>
      <button class="navbar-toggler" type="button" data-bs-toggle="collapse" data-bs-target="#navbarCollapse" aria-controls="navbarCollapse" aria-expanded="false" aria-label="Toggle navigation">
        <span class="navbar-toggler-icon"></span>
      </button>
      <div class="collapse navbar-collapse" id="navbarCollapse">
        <ul class="navbar-nav me-auto mb-2 mb-md-0">
          {% if user.is_authenticated %}
            <li class="nav-item">
              <a class="nav-link" href="{% url 'logout' %}">Log Out</a>
            </li>
          {% else %}
            <li class="nav-item">
              <a class="nav-link" href="{% url 'login' %}">Log In</a>
            </li>
            <li class="nav-item">
              <a class="nav-link" href="{% url 'signup' %}">Sign Up</a>
            </li>
          {% endif %}
        </ul>
      </div>
    </div>
  </nav>
<div class="container">
```

```
{% block content %}  
...  

```

The other step is to update `base.css` so that our body section fits the new navbar.

Code

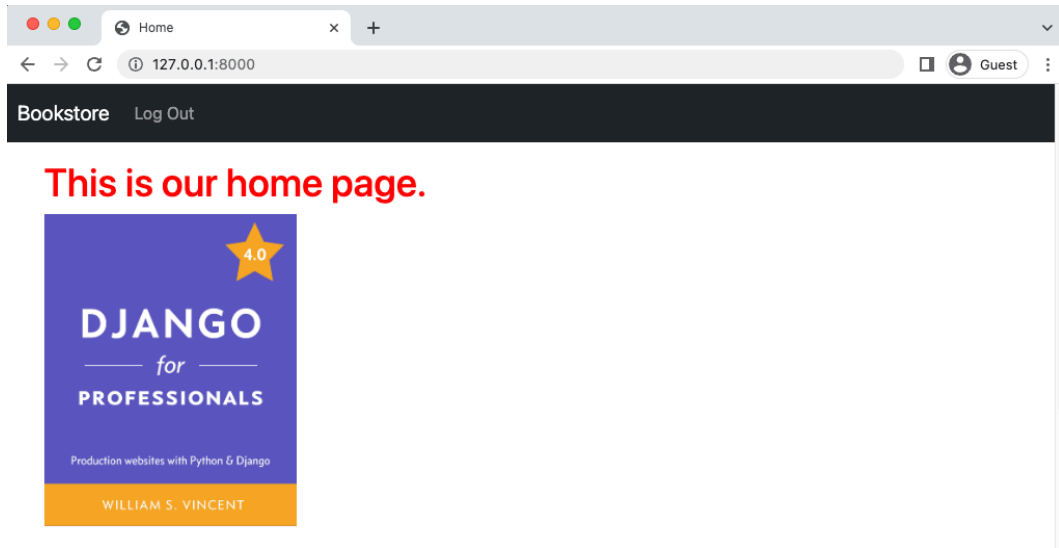
```
/* static/css/base.css */  
body {  
    min-height: 75rem;  
    padding-top: 4.5rem;  
}  
  
h1 {  
    color: red;  
}  
  
img.bookcover {  
    height: 300px;  
    width: auto;  
}
```

The code in our `home.html` template can be cleaned up now too. We don't need to display Log In or Sign Up links. Nor do we need to display a message about the user not being logged in. The reduced `home.html` template should look as follows:

Code

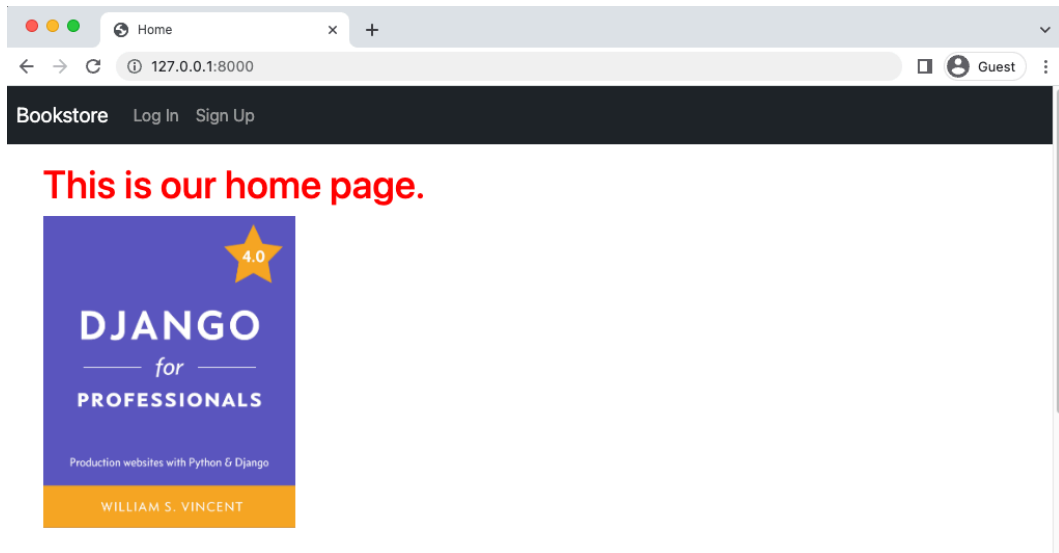
```
<!-- templates/home.html -->  
{% extends "_base.html" %}  
{% load static %}  
  
{% block title %}Home{% endblock title %}  
  
{% block content %}  
    <h1>This is our home page.</h1>  
      
{% endblock content %}
```

Refresh the homepage now to see our new navbar and updated homepage. The web page body just displays the title and book cover.



Homepage with Bootstrap

If you click the “Log Out” link in the navbar it automatically updates it to instead include “Log In” and “Sign Up”.



Homepage with Bootstrap Logged Out

About Page

Let's add an About page to our project now and to the navbar. It is quite straightforward to do now that we have our site's scaffolding configured. Since this will be a static page we don't need a database model involved. However we will need a template, view, and url.

Let's start by creating a new template file called `templates/about.html`. The page will literally just say "About Page" for now while inheriting from `_base.html`.

Code

```
<!-- templates/about.html -->
{% extends "_base.html" %}

{% block title %}About{% endblock title %}

{% block content %}
    <h1>About Page</h1>
{% endblock content %}
```

The view can rely on Django's built-in `TemplateView` just like our homepage.

Code

```
# pages/views.py
from django.views.generic import TemplateView

class HomePageView(TemplateView):
    template_name = "home.html"

class AboutPageView(TemplateView): # new
    template_name = "about.html"
```

And the URL path will be familiar as well. In the `pages/urls.py` file we will first import the necessary view, `AboutPageView`, create a new URL path to `about/`, and provide a URL name of `about`.

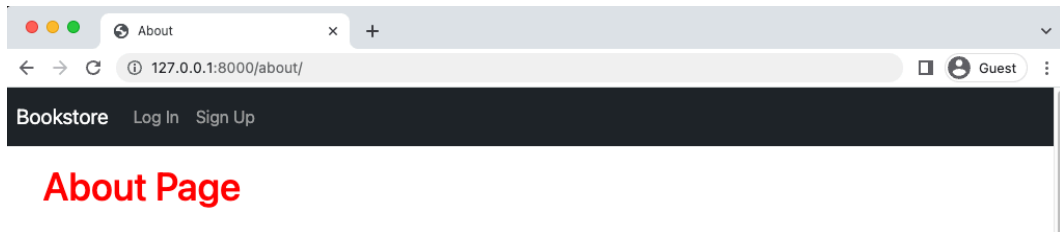
Code

```
# pages/urls.py
from django.urls import path

from .views import HomePageView, AboutPageView # new

urlpatterns = [
    path("about/", AboutPageView.as_view(), name="about"), # new
    path("", HomePageView.as_view(), name="home"),
]
```

If you now visit the URL `http://127.0.0.1:8000/about/` you can see the About page.

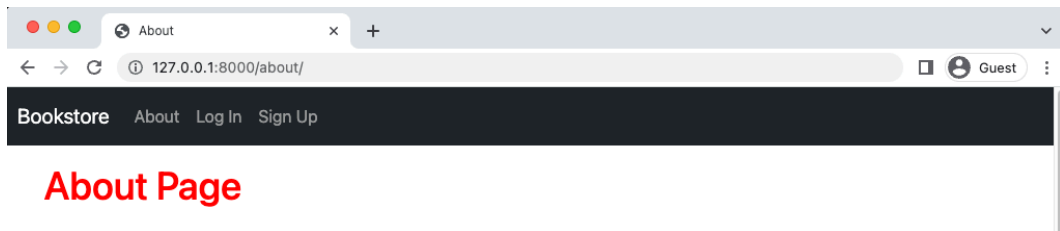
**About Page**

As a final step, update the link in the navbar to the page. Because we provided a name in the URL path of about that's what we'll use alongside the `url` template tag. On line 18 of `_base.html` change the line with the About page link to the following:

Code

```
<!-- templates/_base.html -->
...
<div class="collapse navbar-collapse" id="navbarCollapse">
  <ul class="navbar-nav me-auto mb-2 mb-md-0">
    <li class="nav-item">
      <a class="nav-link" href="{% url 'about' %}">About</a>
    </li>
    {% if user.is_authenticated %}
  ...
```

If you refresh the about page now it will display the “About” link in the navbar.



About Navbar Link

There has been a lot of code so far in this chapter especially in the `_base.html` file. If you are concerned about a small typo it is more than fine to look at [the official source code here](#) and just copy and paste the `templates/_base.html` file if needed.

About Page Tests

Time for tests. We've added a new About page so we should add basic tests for it in `pages/tests.py`. These tests will be very similar to those we added previously for our homepage.

Code

```
# pages/tests.py
from django.test import SimpleTestCase
from django.urls import reverse, resolve

from .views import HomePageView, AboutPageView # new

class HomepageTests(SimpleTestCase):
    ...

class AboutPageTests(SimpleTestCase): # new
    def setUp(self):
        url = reverse("about")
        self.response = self.client.get(url)

    def test_aboutpage_status_code(self):
        self.assertEqual(self.response.status_code, 200)

    def test_aboutpage_template(self):
        self.assertTemplateUsed(self.response, "about.html")
```

```

def test_aboutpage_contains_correct_html(self):
    self.assertContains(self.response, "About Page")

def test_aboutpage_does_not_contain_incorrect_html(self):
    self.assertNotContains(
        self.response, "Hi there! I should not be on the page.")

def test_aboutpage_url_resolves_aboutpageview(self):
    view = resolve("/about/")
    self.assertEqual(
        view.func.__name__,
        AboutPageView.as_view().__name__
    )

```

Run the tests.

Shell

```

$ docker-compose exec web python manage.py test
Found 15 test(s).
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
.....

```

```

Ran 15 tests in 0.161s

```

```

OK
Destroying test database for alias 'default'...

```

They all passed! Good. Now we can feel confident that any future changes we make to our project won't mess up the About page.

Django Crispy Forms

One last update with Bootstrap is to our forms. The popular 3rd party package [django-crispy-forms](#) provides a host of welcome upgrades and has a Bootstrap5 dedicated template pack [crispy-bootstrap5](#) that we can use too. Add both to our `requirements.txt` file as follows:

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycopg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
```

Then stop our Docker container and rebuild it so that `django-crispy-forms` and `crispy-bootstrap5` are available.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

Our Dockerfile has a command to check `requirements.txt` to see if anything has changed and, if so, to install it in our Docker image which is then run by our container as spelled out in `docker-compose.yml`. This is a safe way to install new packages when working with Docker.

Once installed we must add `django-crispy-forms` and `crispy_bootstrap5` to the `INSTALLED_APPS` setting. Note that the app name needs to be `crispy_forms` here! A nice additional feature is to specify `bootstrap4` under `CRISPY_TEMPLATE_PACK` which will provide pre-styled forms for us.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    # Third-party
    "crispy_forms", # new
    "crispy_bootstrap5", # new
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig",
]
```



```
# django-crispy-forms
CRISPY_ALLOWED_TEMPLATE_PACKS = "bootstrap5" # new
CRISPY_TEMPLATE_PACK = "bootstrap5" # new
```

To use Crispy Forms we load `crispy_forms_tags` at the top of a template and add `{{ form|crispy }}` to replace `{{ form.as_p }}` for displaying form fields. We will take this time to also add Bootstrap styling to the Submit button.

Start with the `templates/registration/signup.html` file and make the updates below.

Code

```
<!-- templates/registration/signup.html -->
{% extends "_base.html" %}
{% load crispy_forms_tags %}

{% block title %}Sign Up{% endblock title %}

{% block content %}
    <h2>Sign Up</h2>
    <form method="post">
        {% csrf_token %}
        {{ form|crispy }}
        <button class="btn btn-success" type="submit">Sign Up</button>
    </form>
{% endblock content %}
```

Then navigate to the sign up page at `http://127.0.0.1:8000/accounts/signup/`.

Sign Up

Email address

Username*

Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.

Password*

- Your password can't be too similar to your other personal information.
- Your password must contain at least 8 characters.
- Your password can't be a commonly used password.
- Your password can't be entirely numeric.

Password confirmation*

Enter the same password as before, for verification.

Sign Up

Sign Up Page with Crispy Forms

Next update `templates/registration/login.html` as well with `crispy_forms_tags` at the top and `{{ form|crispy }}` in the form.

Code

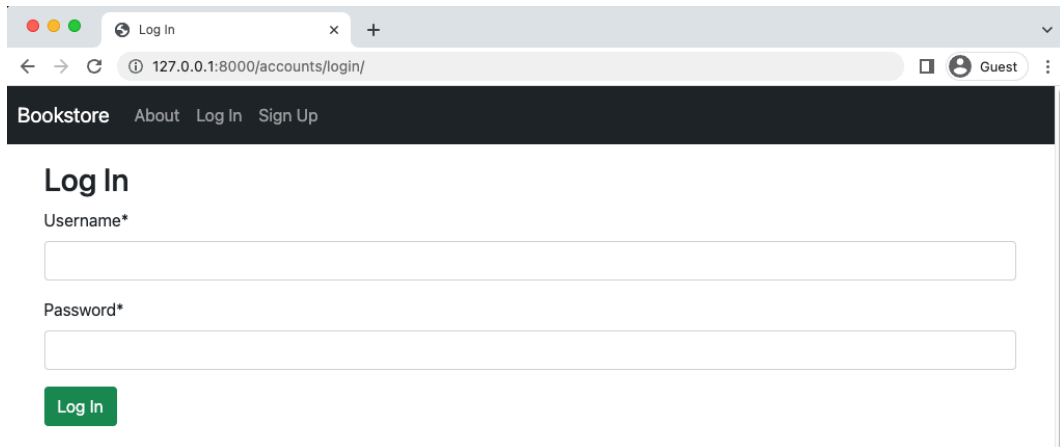
```
<!-- templates/registration/login.html -->
{% extends "_base.html" %}
{% load crispy_forms_tags %}

{% block title %}Log In{% endblock title %}

{% block content %}
<h2>Log In</h2>
<form method="post">
  {% csrf_token %}
  {{ form|crispy }}
  <button class="btn btn-success" type="submit">Log In</button>
</form>
```

```
{% endblock content %}
```

And navigate to the log in page at `http://127.0.0.1:8000/accounts/login/`.



Log In Page with Crispy Forms

Git

Wrapping up we should always do a Git commit for our work. Check the status of changes in this chapter, add them all, and then provide a commit message.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch7'
```

As always you can compare your code with the [official code on Github](#) if there are any issues.

Conclusion

Static assets are a core part of every website and in Django we have to take a number of additional steps so they are compiled and hosted efficiently in production. We also saw how easy it is to

add additional static pages, such as our About page, to our existing site. And we added Bootstrap and `django-crispy-forms` to improve the styling of our site and our forms. Later on in the book we'll learn how to use a dedicated content delivery network (CDN) for hosting and displaying our project's static files.

Chapter 8: Advanced User Registration

At this point we have the standard Django user registration implemented. But often that's just the starting point on professional projects. What about customizing things a bit? For example, Django's default username/email/password pattern is somewhat dated these days. It's far more common to simply require email/password for sign up and log in. And really every part of the authentication flow—the forms, emails, pages—can be customized if so desired.

Another major factor in many projects is the need for social authentication, that is handling sign up and log in via a third-party service like Google, Facebook, and so on.

We could implement our own solutions here from scratch but there are some definite risks: user registration is a complex area with many moving parts and one area where we really do not want to make a security mistake.

For this reason, many professional Django developers rely on the popular third-party [django-allauth](#). Adding any third party package should come with a degree of caution since you *are* adding another dependency to your technical stack. It's important to make sure any package is both up-to-date and well tested. Fortunately `django-allauth` is both.

At the cost of a little bit of *magic* it addresses all of these concerns and makes customization much, much easier.

django-allauth

We will install `django-allauth` in the usual manner. Start off by adding it to the existing `requirements.txt` file.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycopg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
```

Then spin down the currently running Docker container, rebuild our Docker image, and start up a new container.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

Our website will still function the same as before since we haven't explicitly told Django about this new `django-allauth` package. To do that we need to update the `INSTALLED_APPS` config within our `django_project/settings.py` file adding Django's built-in, but optional, [sites framework](#), `allauth`, and its account feature, `allauth.account`.

`django-allauth` also requires an update to Django's [AUTHENTICATION_BACKENDS](#). By default, Django includes `ModelBackend` which is needed to login by username in the Django admin. `django-allauth` needs its own additional backend, `AuthenticationBackend`, so users can login by e-mail.

Here is what the complete updates look like in the `django_project/settings.py` file.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    "django.contrib.sites", # new
    # Third-party
    "crispy_forms",
    "crispy_bootstrap5",
    "allauth", # new
    "allauth.account", # new
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig",
]

# django-allauth config
SITE_ID = 1 # new
```

AUTHENTICATION_BACKENDS

The `settings.py` file created by Django for any new project contains a number of explicit settings—those that we see in the file already—as well as a longer additional list of implicit settings that exist but aren’t visible. This can be confusing at first. The complete list of settings configurations [is available here](#).

An example is the `AUTHENTICATION_BACKENDS` setting. Under the hood Django sets this to `'django.contrib.auth.backends.ModelBackend'`, which is used when Django attempts to authenticate a user. We could add the following line to `django_project/settings.py` and the current behavior would remain unchanged:

Code

```
AUTHENTICATION_BACKENDS = (  
    "django.contrib.auth.backends.ModelBackend",  
)
```

However, for `django-allauth` we need to add its specific authentication options, too, which will allow us to switch over to using login via e-mail in a moment. At the bottom of your `django_`-project/`settings.py` file add the following section:

Code

```
# django_project/settings.py  
# django-allauth config  
SITE_ID = 1  
AUTHENTICATION_BACKENDS = (  
    "django.contrib.auth.backends.ModelBackend",  
    "allauth.account.auth_backends.AuthenticationBackend", # new  
)
```

EMAIL_BACKEND

Another configuration implicitly set by is `EMAIL_BACKEND`. By default Django will look for a configured `SMTP server` to send emails.

`django-allauth` will send such an email upon a successful user registration, which we can and will customize later, but since we don't yet have a SMTP server properly configured, it will result in an error.

The solution, for now, is to have Django output any emails to the command line console instead. Thus we can override the default, implicit config by using `console` instead of `smtp`. Add this at the bottom of the `settings.py` file.

Code

```
# django_project/settings.py
# django-allauth config
SITE_ID = 1
AUTHENTICATION_BACKENDS = (
    "django.contrib.auth.backends.ModelBackend",
    "allauth.account.auth_backends.AuthenticationBackend",
)
EMAIL_BACKEND = "django.core.mail.backends.console.EmailBackend" # new
```

ACCOUNT_LOGOUT_REDIRECT

There's one more subtle change to make to our configurations at this time. If you look at the [configurations page](#) again you'll see there is a setting for `ACCOUNT_LOGOUT_REDIRECT` that defaults to the path of the homepage at `/`.

In our current `settings.py` file we have the following two lines for redirects which point to the homepage via its URL name of `"home"`.

Code

```
# django_project/settings.py
LOGIN_REDIRECT_URL = "home"
LOGOUT_REDIRECT_URL = "home"
```

The issue is that `django-allauth`'s `ACCOUNT_LOGOUT_REDIRECT` actually overrides the built-in `LOGOUT_REDIRECT_URL` but since they both point to the homepage this change may not be immediately apparent. To future-proof our application—since maybe we don't want to always redirect to the homepage on logout—we should be explicit here with the logout redirect.

We can also move the two redirect lines under our `django-allauth config` section. This is what the entire `django-allauth config` section should look like at this time.

Code

```
# django_project/settings.py
# django-allauth config
LOGIN_REDIRECT_URL = "home"
ACCOUNT_LOGOUT_REDIRECT = "home" # new
SITE_ID = 1
AUTHENTICATION_BACKENDS = (
    "django.contrib.auth.backends.ModelBackend",
    "allauth.account.auth_backends.AuthenticationBackend",
)
EMAIL_BACKEND = "django.core.mail.backends.console.EmailBackend"
```

Given that we have made many changes to our `django_project/settings.py` file let's now run `migrate` to update our database.

Shell

```
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, contenttypes, sessions, sites
Running migrations:
  Applying account.0001_initial... OK
  Applying account.0002_email_max_length... OK
  Applying sites.0001_initial... OK
  Applying sites.0002_alter_domain_unique... OK
```

URLs

We also need to swap out the built-in `auth` app URLs for `django-allauth`'s own `allauth` app. We'll still use the same `accounts/` URL path, however, since we'll be using `django-allauth`'s templates and routes for sign up we can delete the URL path for our `accounts` app, too.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("admin/", admin.site.urls),
    # User management
    path("accounts/", include("allauth.urls")), # new
    # Local apps
    path("", include("pages.urls")),
]
```

At this point we *could* further delete `accounts/urls.py` and `accounts/views.py` which were both created solely for our hand-written sign up page and are no longer being used.

Templates

Django's auth app looks for templates within a `templates/registration` directory, but `allauth` prefers they be located within a `templates/account` directory. So we will create a new directory called `templates/account` and then copy over our existing `login.html` and `signup.html` templates into it.

Shell

```
$ mkdir templates/account
$ mv templates/registration/login.html templates/account/login.html
$ mv templates/registration/signup.html templates/account/signup.html
```

It's easy to add an `s` onto `account` here by accident, but don't or you'll get an error. The correct directory is `templates/account/`.

We can delete the `templates/registration` directory at this point since it is no longer needed.

Shell

```
$ rm -r templates/registration
```

`rm` means remove and `-r` means do it recursively, which is necessary whenever you are dealing with a directory. If you'd like further information on this command you can type `man rm` to read the manual.

Note that if you ever see a command that includes `rm -rf`—and especially `sudo rm -rf`—use incredible caution! It is possible to wipe your entire computer with this command. Don't ever execute it unless you are 100% sure the result is intended.

The last step is to update the URL links within `templates/_base.html` to use `django-allauth`'s URL names rather than Django's. We do this by adding an `account_` prefix so Django's `'logout'` will now be `'account_logout'`, `'login'` will be `'account_login'`, and `signup` will be `account_signup`.

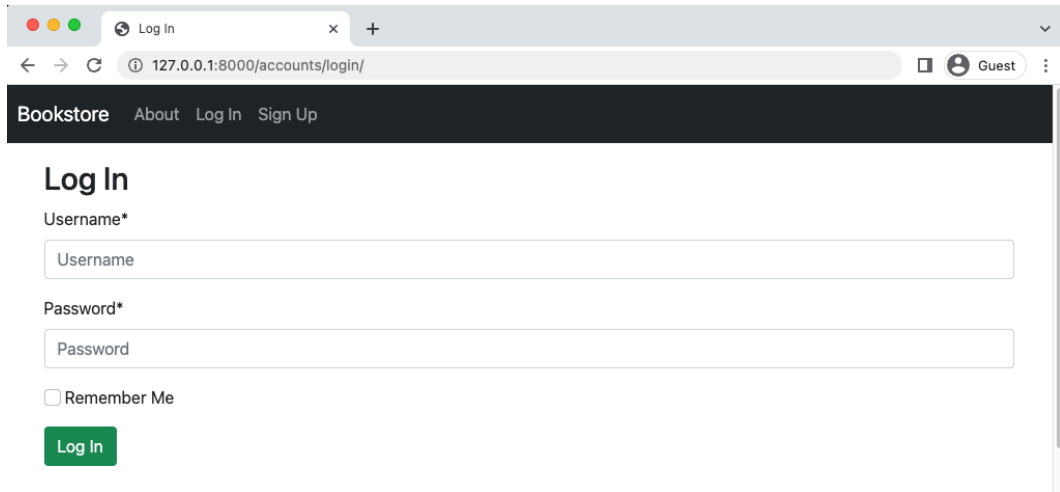
Code

```
<!-- templates/_base.html -->
...
<ul class="navbar-nav me-auto mb-2 mb-md-0">
  <li class="nav-item">
    <a class="nav-link" href="{% url 'about' %}">About</a>
  </li>
  {% if user.is_authenticated %}
  <li class="nav-item">
    <a class="nav-link" href="{% url 'account_logout' %}">Log Out</a>
  </li>
  {% else %}
  <li class="nav-item">
    <a class="nav-link" href="{% url 'account_login' %}">Log In</a>
  </li>
  <li class="nav-item">
    <a class="nav-link" href="{% url 'account_signup' %}">Sign Up</a>
  </li>
  {% endif %}
</ul>
...
```

And we're done!

Log In

Refresh the homepage at `http://127.0.0.1:8000`, log out if you are already logged in, and click on the “Log in” link. The Log In page is now updated page.



The screenshot shows a web browser window with the title 'Log In'. The address bar displays '127.0.0.1:8000/accounts/login/'. The page features a dark navigation bar with the text 'Bookstore' and links for 'About', 'Log In', and 'Sign Up'. The main content area is titled 'Log In' and contains a login form. The form includes a 'Username*' label, a text input field with 'Username' placeholder text, a 'Password*' label, a text input field with 'Password' placeholder text, a checkbox labeled 'Remember Me', and a green 'Log In' button.

Log In Page

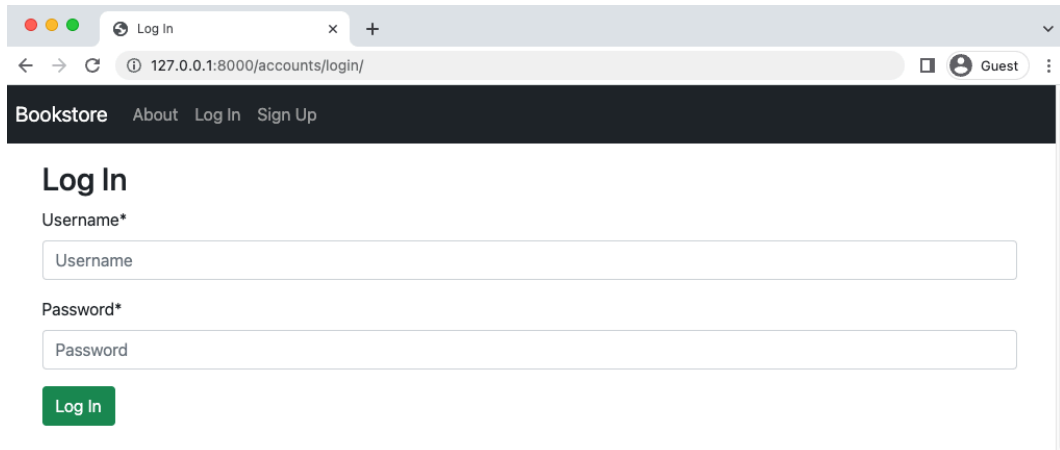
Note the new “Remember Me” box option. This is the first of many [configurations](#) that `django-allauth` provides. The default `None` asks the user if they want their session to be remembered so they don’t have to log in again. It can also be set to `False` to not remember or `True` to always remember. We’ll choose `True` which is how a traditional Django log in page would work.

Under the `# django-allauth config` section of the `django_project/settings.py` file add a new line for this.

Code

```
# django_project/settings.py
# django-allauth config
...
ACCOUNT_SESSION_REMEMBER = True # new
```

Refresh the “Log In” page and the box is gone!



A screenshot of a web browser showing the 'Log In' page. The browser's address bar displays '127.0.0.1:8000/accounts/login/'. The page has a dark header with 'Bookstore' and navigation links 'About', 'Log In', and 'Sign Up'. The main content area is titled 'Log In' and contains two input fields: 'Username*' and 'Password*'. Below these fields is a green 'Log In' button. The browser's user profile shows 'Guest'.

Log In Page No Box

If you try out the log in form with your superuser account it will redirect back to the homepage with a welcome message. Click on the “Log Out” link.



A screenshot of a web browser showing the 'Sign Out' page. The browser's address bar displays '127.0.0.1:8000/accounts/logout/'. The page has a dark header with 'Bookstore' and navigation links 'About', 'Log In', and 'Sign Up'. The main content area is titled 'Sign Out' and contains a confirmation message: 'Are you sure you want to sign out?'. Below this message is a 'Sign Out' button. The browser's user profile shows 'Guest'.

Log Out Page

Rather than directly log us out, django-allauth has an intermediary “Log Out” page which we can customize to match the rest of our project.

Log Out

We will now update the default Log Out template by creating a `templates/account/logout.html` file to override it. Do so now in your text editor. As in our other templates it will extend `_base.html` and include Bootstrap styling on the submitted button.

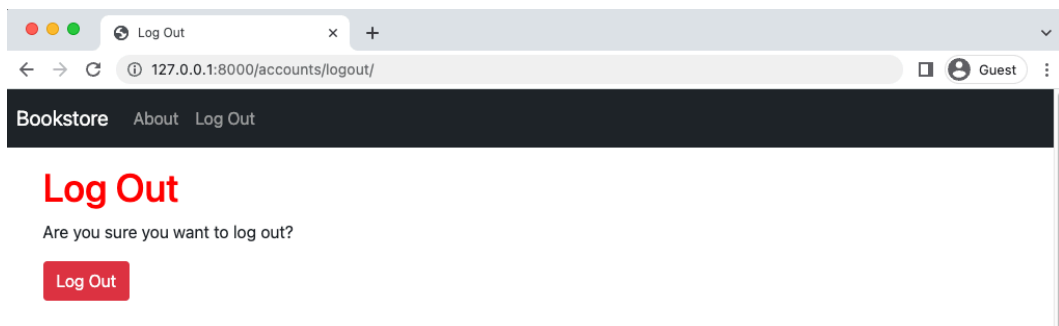
Code

```
<!-- templates/account/logout.html -->
{% extends "_base.html" %}
{% load crispy_forms_tags %}

{% block title %}Log Out{% endblock %}

{% block content %}
  <h1>Log Out</h1>
  <p>Are you sure you want to log out?</p>
  <form method="post" action="{% url 'account_logout' %}">
    {% csrf_token %}
    {{ form|crispy }}
    <button class="btn btn-danger" type="submit">Log Out</button>
  </form>
{% endblock content %}
```

Go ahead and refresh the page.

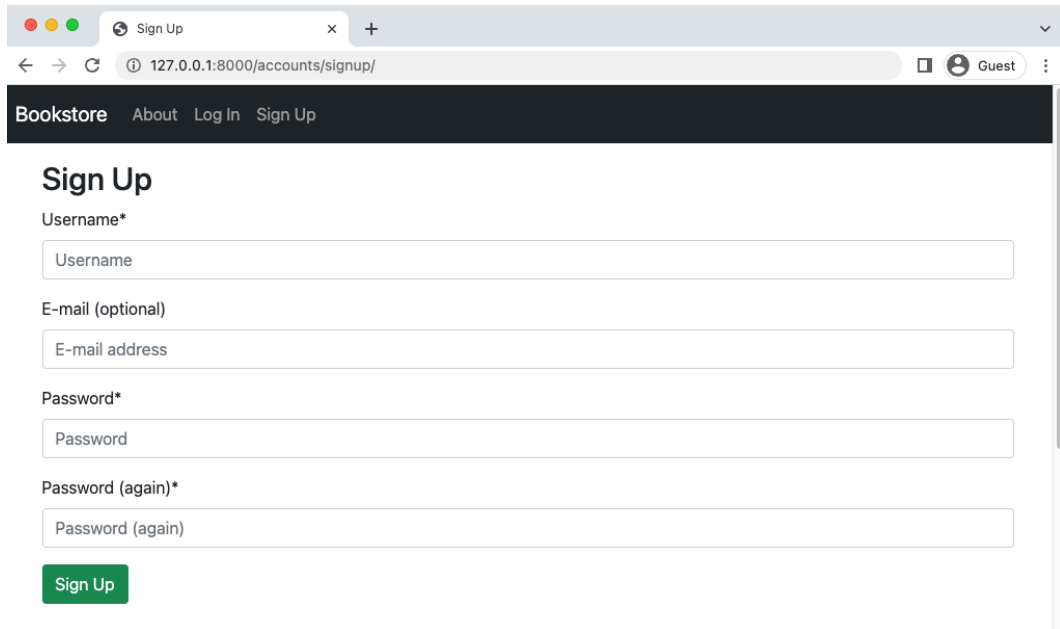


Custom Log Out Page

Then click on the “Log Out” link to complete the process.

Sign Up

At the top of our website, in the nav bar, click on link for “Sign Up” which has Bootstrap and `django-crispy-forms` styling.

A screenshot of a web browser showing a 'Sign Up' page. The browser's address bar shows the URL '127.0.0.1:8000/accounts/signup/'. The page has a dark navigation bar at the top with links for 'Bookstore', 'About', 'Log In', and 'Sign Up'. The 'Sign Up' link is highlighted. Below the navigation bar, the page title 'Sign Up' is displayed. The form contains four input fields: 'Username*' (with placeholder 'Username'), 'E-mail (optional)' (with placeholder 'E-mail address'), 'Password*' (with placeholder 'Password'), and 'Password (again)*' (with placeholder 'Password (again)'). A green 'Sign Up' button is located at the bottom of the form.

Sign Up Page

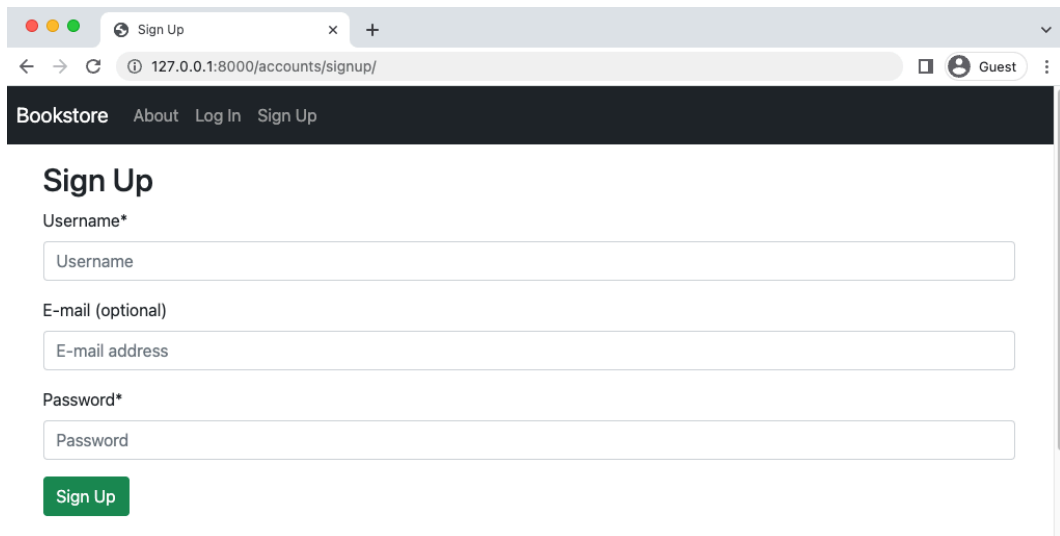
An optional customization we can make via `django-allauth` is to only ask for a password once. Since we'll configure password change and reset options later, there's less of a risk that a user who types in the password incorrectly will be locked out of their account.

This change is, if you look at the [django-allauth configuration options](#), is a one-liner.

Code

```
# django_project/settings.py
# django-allauth config
...
ACCOUNT_SIGNUP_PASSWORD_ENTER_TWICE = False # new
```

Refresh the page and the form will update itself to remove the additional password line.



The screenshot shows a web browser window with the title 'Sign Up'. The address bar displays '127.0.0.1:8000/accounts/signup/'. The page has a dark navigation bar with links for 'Bookstore', 'About', 'Log In', and 'Sign Up'. The main content area is titled 'Sign Up' and contains three input fields: 'Username*', 'E-mail (optional)', and 'Password*'. Below the fields is a green 'Sign Up' button. The browser's user profile shows 'Guest'.

Sign Up with Single Password

Now create a new user to confirm everything works. We can call the user `testuser1`, use `testuser1@email.com` as email, and `testpass123` as the password. Upon submit it will redirect you to the homepage.

Remember how we configured email to output to the console? `django-allauth` automatically sends an email upon registration which we can view by typing `docker-compose logs`.

Shell

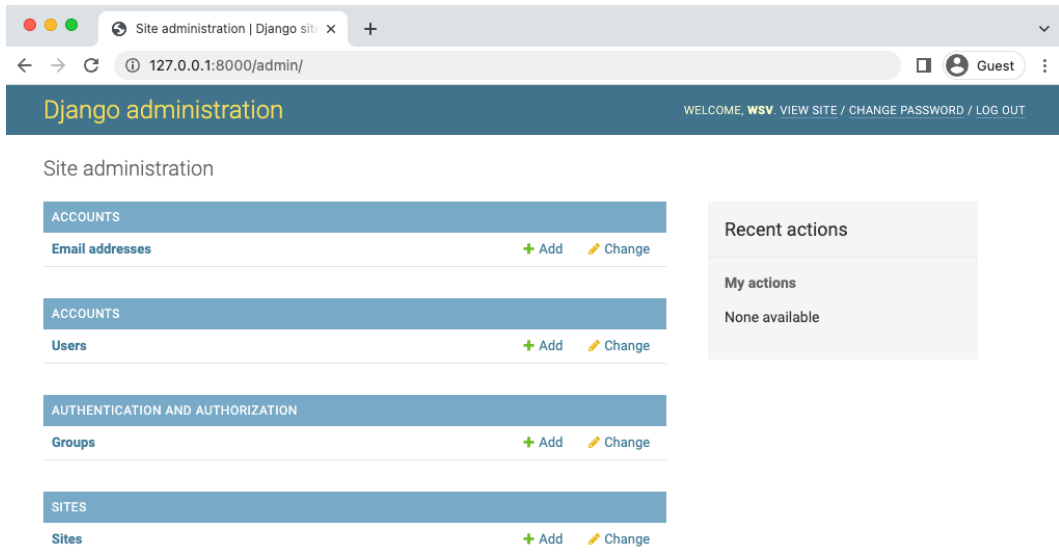
```
$ docker-compose logs
...
web_1 | Content-Type: text/plain; charset="utf-8"
web_1 | MIME-Version: 1.0
web_1 | Content-Transfer-Encoding: 7bit
web_1 | Subject: [example.com] Please Confirm Your E-mail Address
web_1 | From: webmaster@localhost
web_1 | To: testuser@email.com
web_1 | Date: Tue, 17 May 2022 14:04:15 -0000
web_1 | Message-ID: <155266195771.15.17095643701553564393@cdab877c4af3>
web_1 |
web_1 | Hello from example.com!
web_1 |
web_1 | You're receiving this e-mail because user testuser1 has given yours as
an e-mail address to connect their account.
web_1 |
web_1 | To confirm this is correct, go to http://127.0.0.1:8000/accounts/
confirm-emailMQ:1h4oIn:GYETeK5dRClGjcA8Nbu0oyvafA/
web_1 |
web_1 | Thank you from example.com!
web_1 | example.com
web_1 | -----
...

```

There it is. Later on in the book we will customize this message and configure a proper email service to send it to actual users.

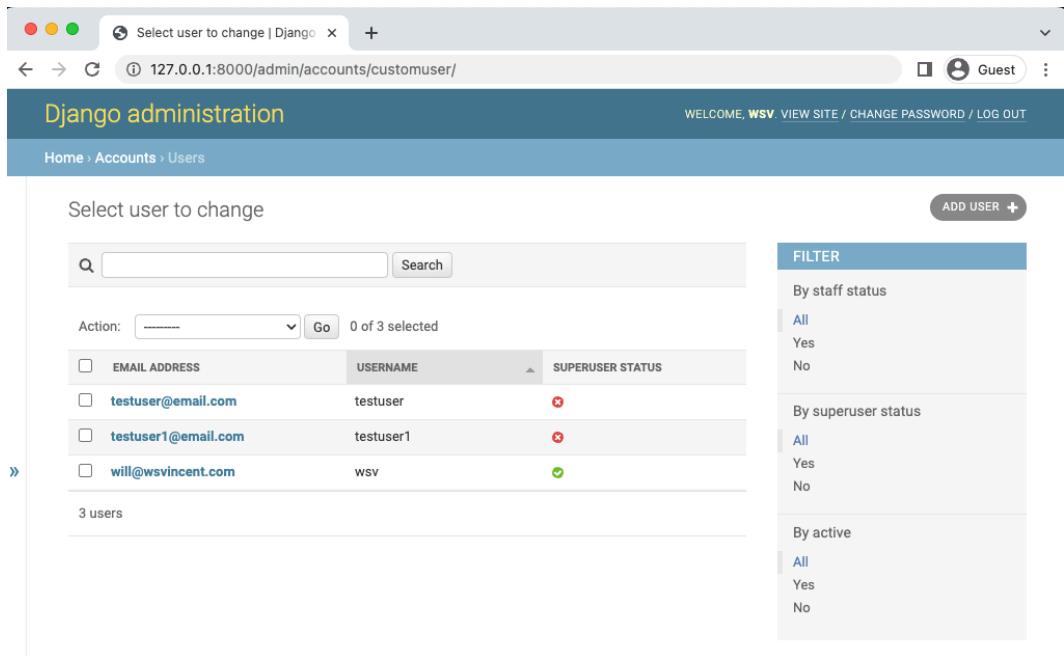
Admin

Log in to the admin with your superuser account at <http://127.0.0.1:8000/admin/> and we can see it, too, has changed now that `django-allauth` is involved.



Admin Homepage

There are two new sections: `Accounts` and `Sites` courtesy of our recent work. If you click on the `Users` section we see our traditional view that shows the three current user accounts.



The screenshot shows the Django administration interface for user management. The browser address bar indicates the URL is `127.0.0.1:8000/admin/accounts/customuser/`. The page title is "Select user to change".

The main content area features a search bar and a table of users. The table has columns for "EMAIL ADDRESS", "USERNAME", and "SUPERUSER STATUS". There are three users listed:

EMAIL ADDRESS	USERNAME	SUPERUSER STATUS
testuser@email.com	testuser	No
testuser1@email.com	testuser1	No
will@wsvincent.com	wsv	Yes

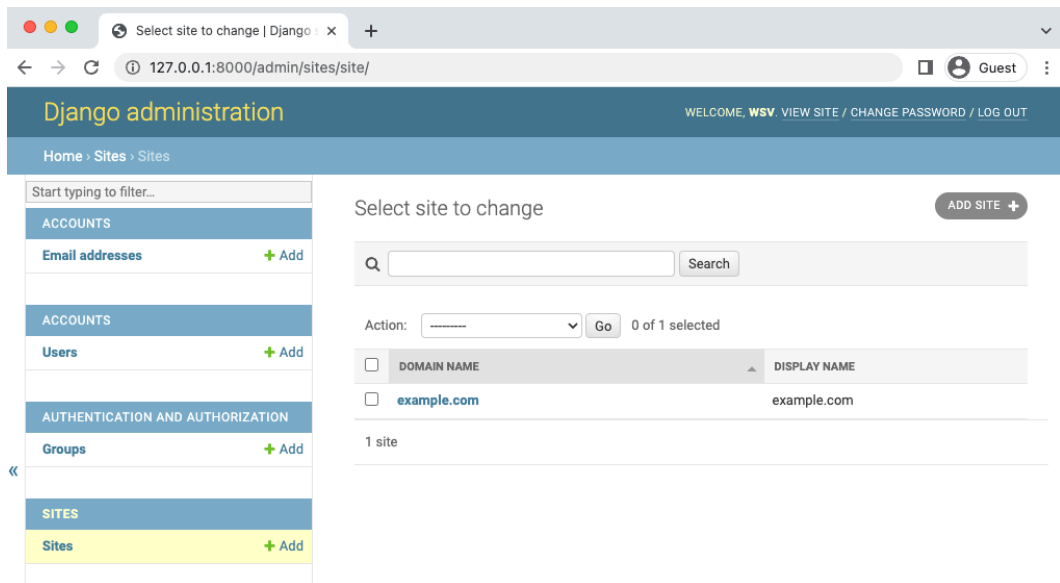
Below the table, it says "3 users".

The right sidebar contains filter options:

- By staff status: All, Yes, No
- By superuser status: All, Yes, No
- By active: All, Yes, No

Admin Users

If you expand the admin sidebar on the leftside of the page we can go directly to the Sites section to see what the Django sites framework provides. We'll update both the Domain Name and the Display Name in a later chapter on configuring email.



Admin Sites

Email Only Login

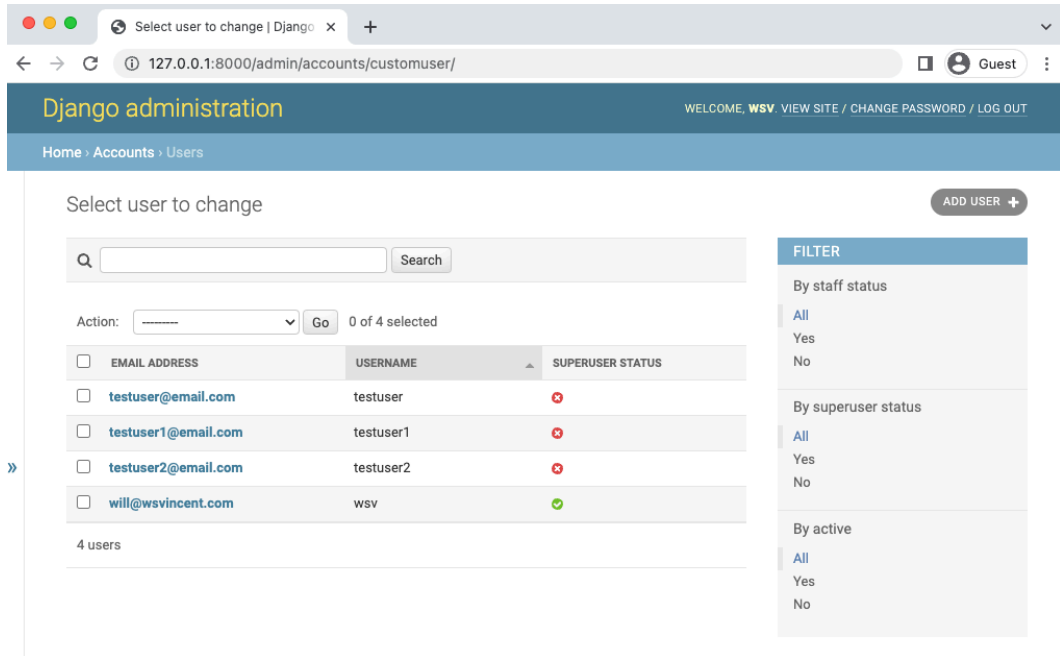
It's time to really use `django-allauth`'s [extensive list of configurations](#) by switching over to using just email for login, not username. This requires a few changes. First we'll make a username not required, but set `email` instead to required. Then we'll require `email` to be unique and the authentication method of choice.

Code

```
# django_project/settings.py
# django-allauth config
...
ACCOUNT_USERNAME_REQUIRED = False # new
ACCOUNT_AUTHENTICATION_METHOD = "email" # new
ACCOUNT_EMAIL_REQUIRED = True # new
ACCOUNT_UNIQUE_EMAIL = True # new
```

Navigate back to the homepage and click on “Log Out” since you’ll be logged in with your superuser account. Then click on the navbar link for “Sign Up” and create an account for `testuser2@email.com` with `testpass123` as the password.

After being redirected to the homepage upon success, go into the admin to inspect what actually happened. Log in with your superuser account and navigate to the Users section.



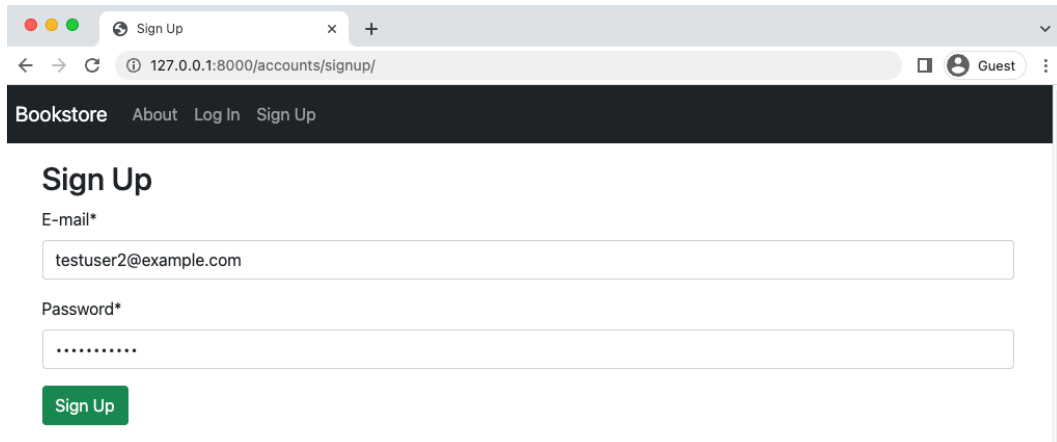
Admin Users

We can see that `django-allauth` automatically populated a username for us based on the email part before the `@`. This is because our underlying `CustomUser` model still has a `username` field. We didn't delete it.

While this approach may seem a little hackish in fact it works *just fine*. Fully removing the username from the custom user model requires the use of `AbstractBaseUser`, which is an additional, optional step some developers take. It requires far more coding and understanding so it is not recommended unless you really know your way around Django's authentication system!

There is, however, an edge case here that we should look into: what happens if we have `testuser2@email.com` and then a sign up for `testuser2@example.com`? Wouldn't that result in a username of `testuser2` for both which would cause a conflict? Let's try it out!

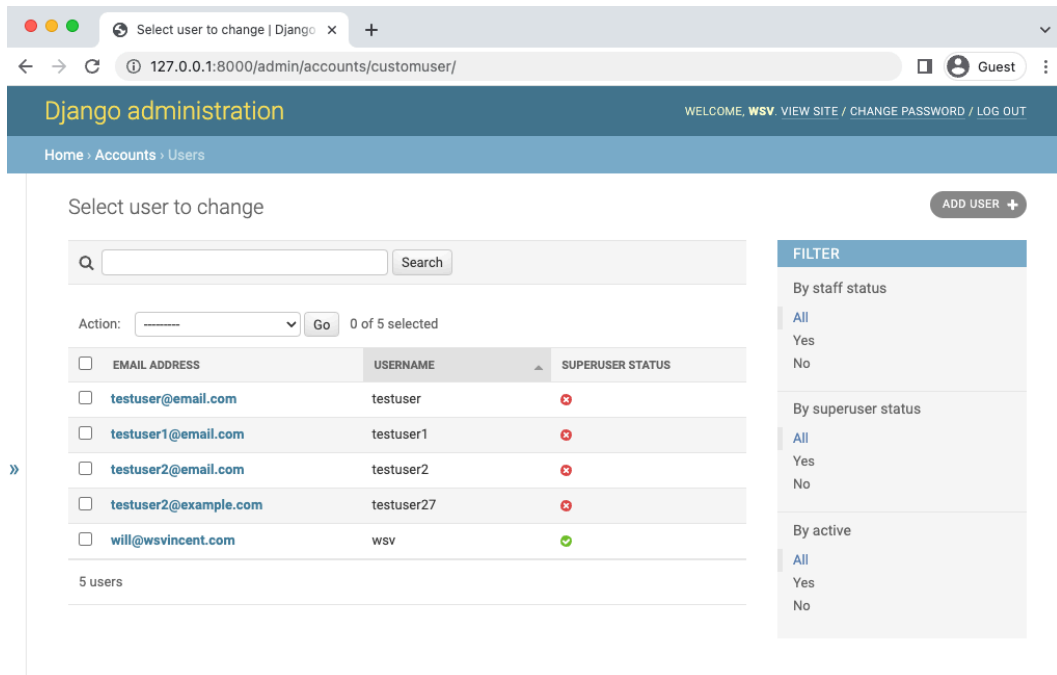
Log out of the admin, on the Sign Up Page create an account for `testuser2@example.com`.



The screenshot shows a web browser window with the address bar displaying `127.0.0.1:8000/accounts/signup/`. The page has a dark header with the text "Bookstore" and links for "About", "Log In", and "Sign Up". The main content area is titled "Sign Up" and contains two input fields: "E-mail*" with the value "testuser2@example.com" and "Password*" with masked characters ".....". A green "Sign Up" button is located below the password field.

Sign Up Form

Now log back into the admin and go to our Users section.



The screenshot shows the Django administration interface for the "Users" section. The breadcrumb trail is "Home > Accounts > Users". The page title is "Django administration" and the welcome message is "WELCOME, wsv. VIEW SITE / CHANGE PASSWORD / LOG OUT". The main content area is titled "Select user to change" and includes a search bar and an "ADD USER +" button. Below the search bar is a table of users with columns for "EMAIL ADDRESS", "USERNAME", and "SUPERUSER STATUS". The table contains five rows of user data. To the right of the table is a "FILTER" sidebar with three sections: "By staff status", "By superuser status", and "By active", each with "All", "Yes", and "No" options.

EMAIL ADDRESS	USERNAME	SUPERUSER STATUS
<input type="checkbox"/> testuser@email.com	testuser	<input type="checkbox"/>
<input type="checkbox"/> testuser1@email.com	testuser1	<input type="checkbox"/>
<input type="checkbox"/> testuser2@email.com	testuser2	<input type="checkbox"/>
<input type="checkbox"/> testuser2@example.com	testuser27	<input type="checkbox"/>
<input type="checkbox"/> will@wsvincent.com	wsv	<input checked="" type="checkbox"/>

5 users

Admin Users

django-allauth automatically adds a two-digit string to the username. In this case it is 20 so

testuser2 becomes testuser27. This two-digit string will be randomly generated for us.

Tests

Time for tests. Like any good third-party package `django-allauth` comes with its own tests so we don't need to re-test its core functionality, just confirm that our project works as expected.

There are several errors now with our current tests though related to `SignUpPageTests` since we're using `django-allauth` now for this rather than our own views, forms, and urls.

Let's update the tests. Starting at the top we are no longer using `CustomUserCreationForm` or `SignUpPageView` so we can remove both imports. We are using `django-allauth`'s URL path and name now for the sign up page which is `account_signup`, not the `signup` we named it previously. How did that it was `account_signup`? I looked at [the source code](#) and found the URL name.

The updated code looks as follows:

Code

```
# accounts/tests.py
from django.contrib.auth import get_user_model
from django.test import TestCase
from django.urls import reverse, resolve

class CustomUserTests(TestCase):
    ...

class SignUpPageTests(TestCase): # new
    username = "newuser"
    email = "newuser@email.com"

    def setUp(self):
        url = reverse("account_signup")
        self.response = self.client.get(url)

    def test_signup_template(self):
        self.assertEqual(self.response.status_code, 200)
        self.assertTemplateUsed(self.response, "account/signup.html")
        self.assertContains(self.response, "Sign Up")
        self.assertNotContains(self.response, "Hi there! I should not be on the page.")
```



```
def test_signup_form(self):
    new_user = get_user_model().objects.create_user(self.username, self.email)
    self.assertEqual(get_user_model().objects.all().count(), 1)
    self.assertEqual(get_user_model().objects.all()[0].username, self.username)
    self.assertEqual(get_user_model().objects.all()[0].email, self.email)
```

Run the tests again.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
```

```
.....
```

```
-----
Ran 14 tests in 0.410s
```

```
OK
```

```
Destroying test database for alias 'default'...
```

Social

If you want to add social authentication it's just a few settings. I have a [complete tutorial online](#) for integrating Github. The process is similar for Google, Facebook, and all the rest `django-allauth` supports. [Here is the complete list of providers](#).

Git

As always commit the code changes with Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch8'
```

And if there are any issues, compare with the [official source code on Github](#).

Conclusion

We now have a user registration flow that works and can be quickly extended into social authentication if needed. In the next chapter we'll add environment variables to our project for greater security and flexibility.

Chapter 9: Environment Variables

[Environment variables](#) are variables that can be loaded into the operating environment of a project at run time as opposed to hard coded into the codebase itself. They are considered an integral part of the popular [Twelve-Factor App Design](#) methodology and a Django best practice because they allow a greater level of security and simpler local/production configurations.

Why greater security? Because we can store truly secret information—database credentials, API keys, and so on—separate from the actual code base. This is a good idea because using a version control system, like `git`, means that it only takes one bad commit for credentials to be added in there forever. Which means that *anyone* with access to the codebase has full control over the project. This is very, very dangerous. It's much better to limit who has access to the application and environment variables provide an elegant way to do so.

A secondary advantage is that environment variables make it much easier to switch between local and production code environments. As we will see, there are a number of setting configurations that Django uses by default intended to make local development easier, but which must be changed once the same project is ready for production.

Environs

There are many different ways to work with environment variables in Python but for this project we'll use the [environs](#) package, which has a Django-specific option that installs a number of additional packages that help with configuration.

We will install it by first updating the `requirements.txt` file.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycpg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
environs[django]==9.5.0
```

Then spin down the currently running Docker container, rebuild our Docker image which will contain the new software package, and start up the container again.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

In the `django_project/settings.py` file, there are three lines of imports to add at the top of the file, just under the import of `Path`.

Code

```
# django_project/settings.py
from pathlib import Path
from environs import Env # new

env = Env() # new
env.read_env() # new
```

All set.

SECRET_KEY

For our first environment variable we'll set the `SECRET_KEY`, a randomly generated string used for [cryptographic signing](#) and created whenever the `startproject` command is run. It is very important that `SECRET_KEY` actually be kept, well, secret.

In my `django_project/settings.py` file, it has the following value:

Code

```
# django_project/settings.py
SECRET_KEY = "django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs4)x1"
```

Note that the double quotes (") around the SECRET_KEY make it a Python string. The double quotes are not actually part of the SECRET_KEY value itself, which is an easy mistake to make.

There is a two-step process to switching over to environment variables:

- add the environment variable to the docker-compose.yml file
- update django_project/settings.py to point to the variable

In the docker-compose.yml file, add a section called environment under the web service. It will be a variable that we'll call DJANGO_SECRET_KEY with the value of our existing SECRET_KEY. This is what the updated file looks like:

docker-compose.yml

```
version: '3.9'

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
    depends_on:
      - db
    environment:
      - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs\
4)x1"
  db:
    image: postgres:13
    volumes:
      - postgres_data:/var/lib/postgresql/data/
    environment:
      - "POSTGRES_HOST_AUTH_METHOD=trust"

volumes:
  postgres_data:
```

Note that if your SECRET_KEY includes a dollar sign, \$, then you need to add an additional dollar sign, \$\$\$. This is due to how docker-compose [handles variable substitution](#). Otherwise you will see an error!

The second step is to update the SECRET_KEY configuration within django_project/settings.py.

Code

```
# django_project/settings.py
SECRET_KEY = env("DJANGO_SECRET_KEY")
```

If you refresh the website now you'll likely see an error. Django requires a SECRET_KEY to work and in this case, our value is being stored within docker-compose.yml, which is used to start the container. It won't be applied until we restart the current container which we'll do so now.

Shell

```
$ docker-compose down
$ docker-compose up -d
```

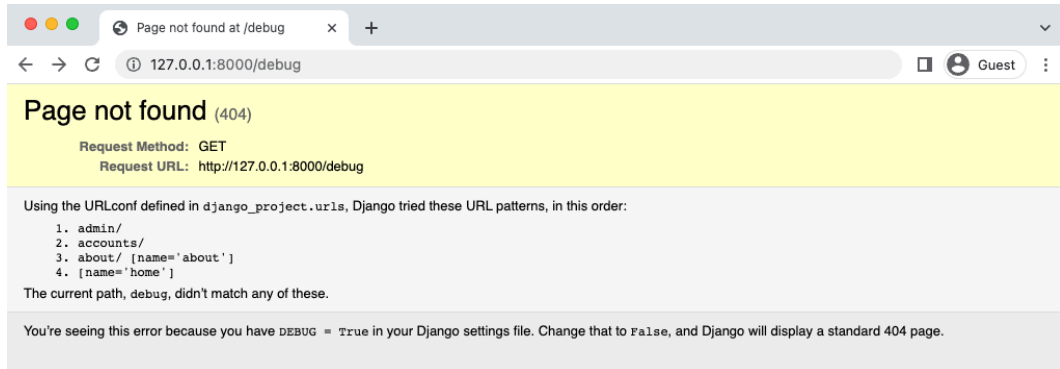
Refresh the page again and everything works as before, which is what we want. Astute readers may notice that even though we are now using an environment variable the actual value of SECRET_KEY is still visible in our source code as it's merely moved to docker-compose.yml which is tracked by Git. This is true! However, when we configure our website for production, we will create a separate file for production purposes—docker-compose-production.yml—and immediately add it to our .gitignore file so it is not tracked in the source code.

For now though, the goal of this chapter is to start using environment variables locally for the values that need to be either truly secret or switched in a production context.

DEBUG and ALLOWED_HOSTS

As the Django [deployment checklist](#) notes, there are a number of settings that must be updated before a website can be deployed safely in production. Chief among them are [DEBUG](#) and [ALLOWED_HOSTS](#).

When `DEBUG` is set to `True`, Django displays a lengthy message and detailed bug report whenever an error occurs. For example, try visiting a page that does not exist such as `/debug`.



Debug Page

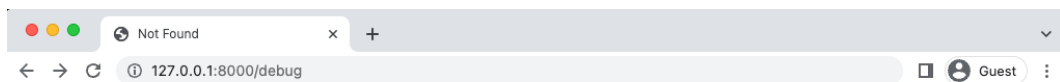
This is great for our purposes as developers, but it is also a roadmap for a hacker in a production setting. When `DEBUG` is set to `False` it is required to add a setting for `ALLOWED_HOSTS`, which controls the specific hosts or domains that can access the website. We'll add the two local ports—`localhost` and `127.0.0.1`—as well as `.herokuapp.com`, which will be used by Heroku for our production website.

Update the `django_project/settings.py` file with two new settings:

Code

```
# django_project/settings.py
DEBUG = False # new
ALLOWED_HOSTS = [".herokuapp.com", "localhost", "127.0.0.1"] # new
```

Then refresh the web page.



Not Found

The requested resource was not found on this server.

Debug Page Not Found

This is the behavior we want for our production site: no information, just a generic message. When we deploy the website we'll use an elegant way to toggle between the two settings, but for now change `DEBUG` to an environment variable called `DJANGO_DEBUG`.

Code

```
# django_project/settings.py
DEBUG = env.bool("DJANGO_DEBUG") # new
```

Then proceed to update `docker-compose.yml` so `DJANGO_DEBUG` is set to `True`.

docker-compose.yml

```
version: '3.9'

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
    depends_on:
      - db
    environment:
      - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs\
4)x1"
      - "DJANGO_DEBUG=True"
  db:
    image: postgres:13
    volumes:
      - postgres_data:/var/lib/postgresql/data/
    environment:
      - "POSTGRES_HOST_AUTH_METHOD=trust"

volumes:
  postgres_data:
```

After the changes refresh the homepage of your website and it will work as before. Everything is working properly.

DATABASES

When we installed `environs[django]` earlier, the Django “goodies” included the elegant [dj-database-url](#) package, which takes all the database configurations needed for our database, SQLite or PostgreSQL. This will be very helpful later on in production.

For now, we can set it to use PostgreSQL locally by adding a default value. Update the existing `DATABASES` configuration with the following:

Code

```
# django_project/settings.py
DATABASES = {
    "default": env.dj_db_url("DATABASE_URL",
        default="postgres://postgres@db/postgres")
}
```

The environment variable, `DATABASE_URL`, will be created by Heroku when we deploy. More on that later. Refresh the website to confirm everything still works properly.

Git

We made a number of important changes in this chapter so make sure to commit the code updates with Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch9'
```

If any issues crop up, compare your files against the [official source code on Github](#).

Conclusion

Adding environment variables is a necessary step for any truly professional Django project. They take some getting used to but are invaluable for switching between local and production

environments as we'll do later on in the book. In the next chapter we'll fully configure our email settings and add password reset functionality.

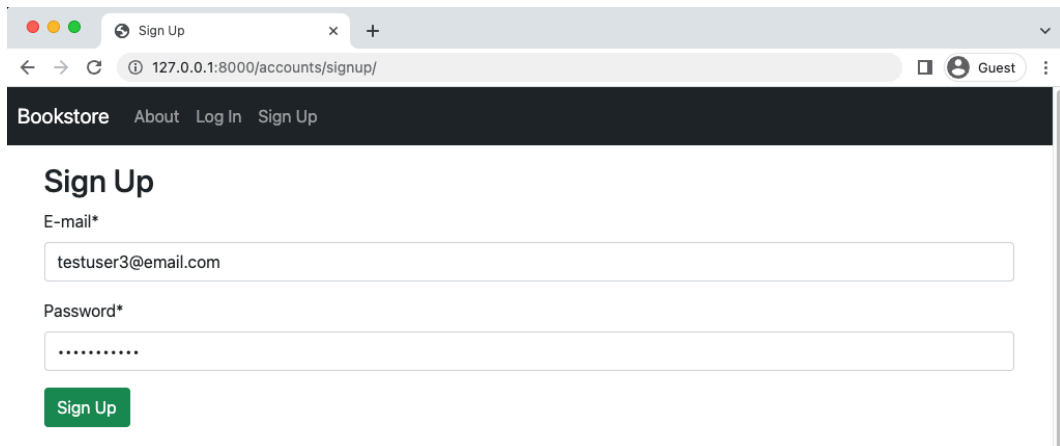
Chapter 10: Email

In this chapter we will fully configure email and add password change and password reset functionality. Currently emails are not actually sent to users. They are simply outputted to our command line console. We'll change that by signing up for a third-party email service, obtaining API keys, and updating our `django_project/settings.py` file. Django takes care of the rest.

So far all of our work—custom user model, pages app, static assets, authentication with `allauth`, and environment variables—could apply to almost *any* new project. After this chapter we will start building out the Bookstore site itself as opposed to foundational steps.

Custom Confirmation Emails

Let's sign up for a new user account to review the current user registration flow. Then we'll customize it. Make sure you are logged out and then navigate to the Sign Up page. I've chosen to use `testuser3@email.com` and `testpass123` as the password.



Sign Up

E-mail*

testuser3@email.com

Password*

.....

Sign Up

testuser3 Sign Up

Upon submission we are redirected to the homepage with a custom greeting *and* an email is sent to us within the command line console. You can see this by checking the logs with `docker-compose logs`. Here is a snippet of the much longer output.

Shell

```
$ docker-compose logs
...
Hello from example.com!

| You're receiving this e-mail because user testuser3 ...
...
```

To customize this email we first need to find the existing templates. Navigate over to the [django-allauth source code on Github](#) and perform a search with a portion of the generated text. For example, “You’re receiving this e-mail.” This leads to the discovery of a `email_confirmation_message.txt` file located within `django-allauth/allauth/templates/account/email`. If you look at this directory’s content there is also a subject line file, `email_confirmation_message.txt` that we can and will change.

To customize these files we’ll override them by recreating the same structure of `django-allauth` in our project. That means creating an `email` directory within the `templates/account` directory.

Shell

```
$ mkdir templates/account/email
```

And then in the text editor create the two new files:

- `templates/account/email/email_confirmation_subject.txt`
- `templates/account/email/email_confirmation_message.txt`

Let’s start with the subject line since it’s the shorter of the two. Here is the default text from `django-allauth`.

email_confirmation_subject.txt

```
{% load i18n %}
{% autoescape off %}
{% blocktrans %}Please Confirm Your E-mail Address{% endblocktrans %}
{% endautoescape %}
```

The first line, `{% load i18n %}`, is to support Django's [internationalization](#) functionality which supports multiple languages. Then comes the Django template tag for [autoescape](#). By default it is "on" and protects against security issues like cross site scripting. But since we can trust the content of the text here, it is turned off.

Finally, we come to our text itself which is wrapped in [blocktrans](#) template tags to support translations. Let's change the text from "E-mail Address" to "Sign Up" to demonstrate that we can.

email_confirmation_subject.txt

```
{% load i18n %}
{% autoescape off %}
{% blocktrans %}Confirm Your Sign Up{% endblocktrans %}
{% endautoescape %}
```

Now turn to the email confirmation message itself. Here is [the current default](#):

email_confirmation_message.txt

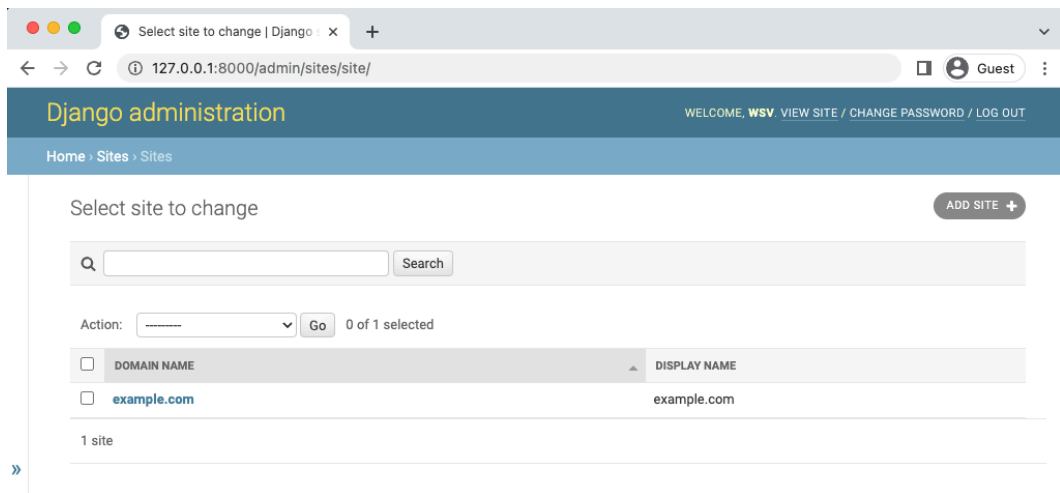
```
{% extends "account/email/base_message.txt" %}
{% load account %}
{% load i18n %}

{% block content %}{% autoescape off %}{% user_display user as user_display %}\
{% blocktrans with site_name=current_site.name site_domain=current_site.domain %}\
You're receiving this e-mail because user {{ user_display }} has given your\
e-mail address to register an account on {{ site_domain }}.

To confirm this is correct, go to {{ activate_url }}\
{% endblocktrans %}{% endautoescape %}{% endblock %}
```

Note that backslashes \ are included for formatting but are not necessary in the raw code. In other words, you can remove them from the code below—and other code examples—as needed.

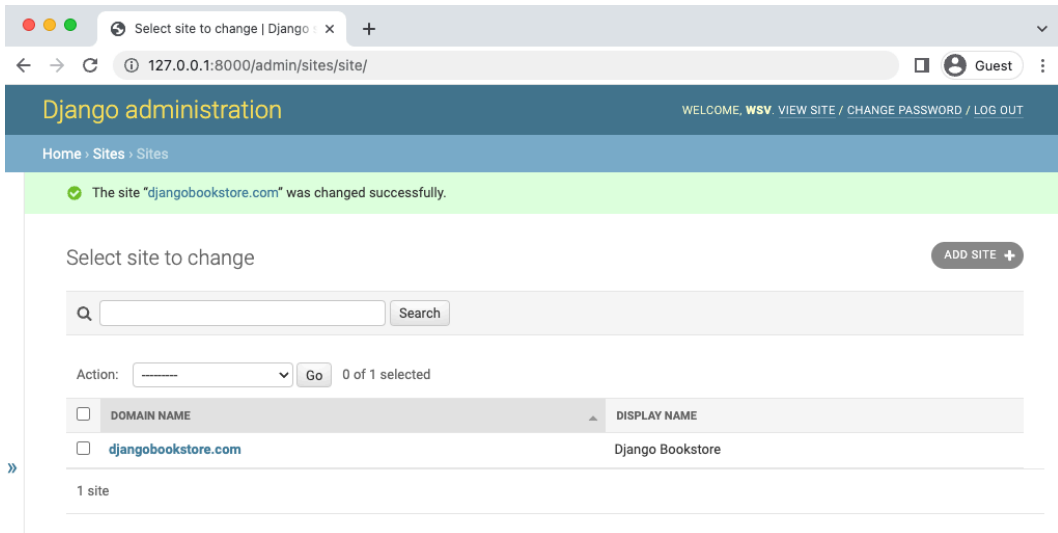
You probably noticed that the default email sent referred to our site as `example.com` which is displayed here as `{{ site_name }}`. Where does that come from? The answer is the `sites` section of the Django admin, which is used by `django-allauth`. So head to the admin at `http://127.0.0.1:8000/admin/` and click on the `Sites` link on the homepage.



Admin Sites

There is a “Domain Name” and a “Display Name” here. Click on `example.com` under “Domain Name” so we can edit it. The **Domain Name** is the full domain name for a site, for example it might be `django bookstore.com`, while the **Display Name** is a human-readable name for the site such as `Django Bookstore`.

Make these updates and click the “Save” button in the lower right corner when done.



Admin Sites - DjangoBookstore.com

Ok, back to our email. Let's customize it a bit. On the first line we can see that this email actually extends another template—`base_message.txt`—that contains the initial greeting of “Hello from...”. To update that we'd just need to add a `base_message.txt` file to the `email` folder. Since this is just for demonstration purposes, trying changing “You're” to “You are” to prove that we can customize the text.

`email_confirmation_message.txt`

```
{% extends "account/email/base_message.txt" %}
{% load account %}
{% load i18n %}

{% block content %}{% autoescape off %}{% user_display user as user_display %}\
{% blocktrans with site_name=current_site.name site_domain=current_site.domain %}\
You are receiving this e-mail because user {{ user_display }} has given your \
e-mail address to register an account on {{ site_domain }}.

To confirm this is correct, go to {{ activate_url }}\
{% endblocktrans %}{% endautoescape %}{% endblock %}
```

One final item to change. Did you notice the email was from `webmaster@localhost`? That's a default setting we can also update via `DEFAULT_FROM_EMAIL`. Let's do that now by adding the following line at the bottom of the `django_project/settings.py` file.

Code

```
# django_project/settings.py
DEFAULT_FROM_EMAIL = "admin@djangobookstore.com" # new
```

Make sure you are logged out of the site and go to the Sign Up page again to create a new user. I've used testuser4@email.com for convenience.

Sign Up testuser4

Sign up and after being redirected to the homepage check the command line to see the message by typing `docker-compose logs`.

Shell

```
...
web_1 | Content-Transfer-Encoding: 7bit
web_1 | Subject: [Django Bookstore] Confirm Your Sign Up
web_1 | From: admin@djangobookstore.com
web_1 | To: testuser4@email.com
web_1 | Date: Tue, 17 May 2022 18:34:50 -0000
web_1 | Message-ID: <156312929025.27.2332096239397833769@87d045aff8f7>
web_1 |
web_1 | Hello from Django Bookstore!
web_1 |
web_1 | You are receiving this e-mail because user testuser4 has given your\
e-mail address to register an account on djangobookstore.com.
web_1 |
web_1 | To confirm this is correct, go to http://127.0.0.1:8000/accounts/\
```

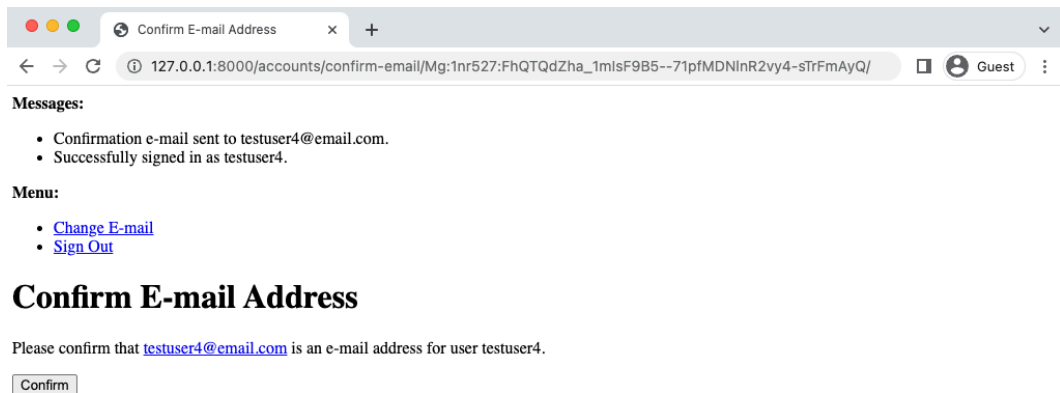


```
confirm-email/Mg:1nr527:FhQTQdZha_1mIsF9B5--71pfMDNlnR2vy4-sTrFmAyQ/  
web_1 |  
web_1 | Thank you from Django Bookstore!  
web_1 | djangobookstore.com
```

And there it is with the new From setting, the new domain djangobookstore.com, and the new message in the email.

Email Confirmation Page

Click on the unique URL link in the email which redirects to the email confirm page.



Confirm Email Page

Not very attractive. Let's update it to match the look of the rest of our site. Searching again in the [django-allauth source code on Github](#) reveals the name and location of this file is templates/account/email_confirm.html. So let's create our own template file with the same name and then update it to extend _base.html and use Bootstrap for the button.

Code

```

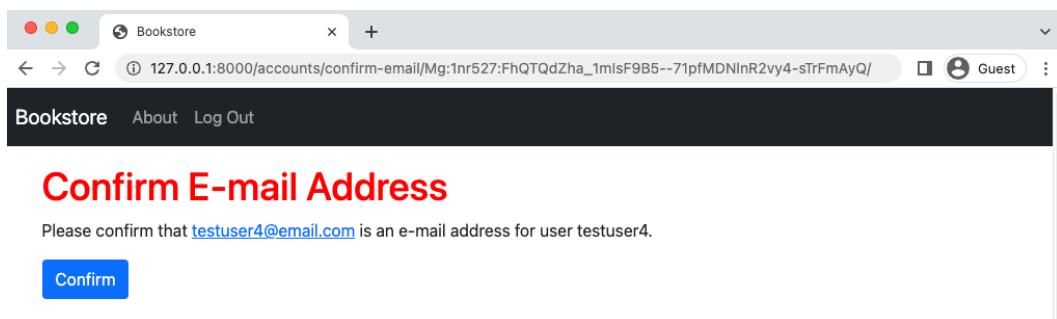
<!-- templates/account/email_confirm.html -->
{% extends "_base.html" %}
{% load i18n %}
{% load account %}

{% block head_title %}{% trans "Confirm E-mail Address" %}{% endblock %}

{% block content %}
  <h1>{% trans "Confirm E-mail Address" %}</h1>
  {% if confirmation %}
    {% user_display confirmation.email_address.user as user_display %}
    <p>{% blocktrans with confirmation.email_address.email as email %}Please confirm
that <a href="mailto:{{ email }}">{{ email }}</a> is an e-mail address for user
{{ user_display }}.{% endblocktrans %}</p>
    <form method="post" action="{% url 'account_confirm_email' confirmation.key %}">
{% csrf_token %}
    <button class="btn btn-primary" type="submit">{% trans 'Confirm' %}</button>
  </form>
  {% else %}
    {% url 'account_email' as email_url %}
    <p>{% blocktrans %}This e-mail confirmation link expired or is invalid. Please
    <a href="{{ email_url }}">issue a new e-mail confirmation request</a>.\
    {% endblocktrans %}</p>
  {% endif %}
{% endblock %}

```

Refresh the page to see our update.



Confirm Email Page Updated

Password Reset and Password Change

Django and `django-allauth` also come with support for additional user account features such as the ability to reset a forgotten password and change your existing password if already logged in.

The locations of the default password reset and password change pages are as follows:

- `http://127.0.0.1:8000/accounts/password/reset/`
- `http://127.0.0.1:8000/accounts/password/change/`

If you go through the flow of each you can find the corresponding templates and email messages in the `django-allauth` source code.

Email Service

The emails we have configured so far are generally referred to as “Transactional Emails” as they occur based on a user action of some kind. This is in contrast to “Marketing Emails” such as, say, a monthly newsletter.

There are many transactional email providers available including SendGrid, MailGun, Amazon’s Simple Email Service. Django is agnostic about which provider is used; the steps are similar for all and many have a free tier available.

After signing up for an account with your email service of choice you’ll often have a choice between using [SMTP](#) or a Web API. SMTP is easier to configure, but a web API is more configurable and robust. Start with SMTP and work your way from there: email configurations can be quite complex in their own right.

After obtaining a username and password with an email provider, a few settings tweaks will allow Django to use them to send emails.

The first step would be to update the `EMAIL_BACKEND` config, which should be near the bottom of the `django_project/settings.py` file since we previously updated it in the `django-allauth` config section.

Code

```
# django_project/settings.py
EMAIL_BACKEND = "django.core.mail.backends.smtp.EmailBackend" # new
```

This means email will no longer output to the command line console but instead attempt to connect with an SMTP server. Then configure `EMAIL_HOST`, `EMAIL_HOST_USER`, `EMAIL_HOST_PASSWORD`, `EMAIL_PORT`, and `EMAIL_USE_TLS` based on the instructions from your email provider as environment variables.

In the official source code the `EMAIL_BACKEND` will remain `console`, but the previous steps are how to add an email service. If you find yourself frustrated properly configuring email, well, you're not alone! Django does at least make it far, far easier than implementing without the benefits of a batteries-included framework.

Git

To commit this chapter's code updates make sure to check the status of changes, add them all, and include a commit message.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch10'
```

If you have any issues compare your code against the [official source code on Github](#).

Conclusion

Configuring email properly is largely a one-time pain. But it is a necessary part of any production website. This concludes the foundational chapters for our Bookstore project. In the next chapter we'll finally start building out the Bookstore itself.

Chapter 11: Books App

In this chapter we will build a Books app for our project that displays all available books and has an individual page for each. We'll also explore different URL approaches starting with using an `id`, then switching to a slug, and finally using a UUID.

To start, we must create this new app which we'll call books.

Shell

```
$ docker-compose exec web python manage.py startapp books
```

And to ensure Django knows about our new app, open your text editor and add the new app to `INSTALLED_APPS` in our `django_project/settings.py` file:

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    "django.contrib.sites",
    # Third-party
    "crispy_forms",
    "crispy_bootstrap5",
    "allauth",
    "allauth.account",
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig",
    "books.apps.BooksConfig", # new
]
```

Ok, initial creation complete!

Models

Ultimately we'll need a model, view, url, and template for each page so it's common to debate where to start. The model is a good place to start as it sets the structure. Let's think about what fields we might want to include. To keep things simple we'll start with a `title`, `author`, and `price`.

Update the `books/models.py` file to include our new Books model.

Code

```
# books/models.py
from django.db import models

class Book(models.Model):
    title = models.CharField(max_length=200)
    author = models.CharField(max_length=200)
    price = models.DecimalField(max_digits=6, decimal_places=2)

    def __str__(self):
        return self.title
```

At the top we're importing the Django class `models` and then creating a `Book` model that subclasses it which means we automatically have access to everything within `django.db.models.Model` and can add additional fields and methods as desired.

For `title` and `author` we're limiting the length to 200 characters and for `price` using a `DecimalField` which is a good choice when dealing with currency.

Below we've specified a `__str__` method to control how the object is outputted in the Admin and Django shell.

Now that our new database model is created we need to create a new migration record for it.

Shell

```
$ docker-compose exec web python manage.py makemigrations
Migrations for 'books':
  books/migrations/0001_initial.py
    - Create model Book
```

And then apply the migration to our database.

Shell

```
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, books, contenttypes, sessions, si\
tes
Running migrations:
  Applying books.0001_initial... OK
```

Our database is configured. Let's add some data to the admin.

Admin

We need a way to access our data for which the Django admin is perfectly suited. Don't forget to update the `books/admin.py` file or else the app won't appear! I forget this step almost every time even after using Django for years.

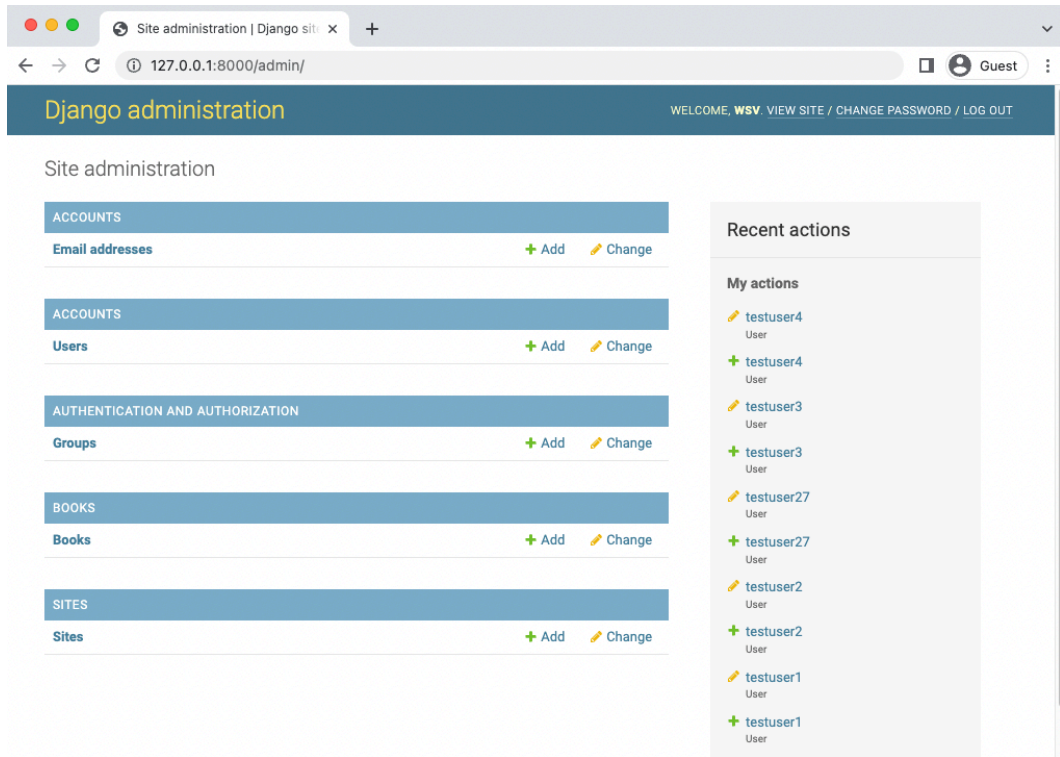
Code

```
# books/admin.py
from django.contrib import admin

from .models import Book

admin.site.register(Book)
```

If you look into the admin at `http://127.0.0.1:8000/admin/` the Books app is now there.

**Admin Homepage**

Let's add a book entry for *Django for Professionals*. Click on the + Add button next to Books to create a new entry. The title is “Django for Professionals”, the author is “William S. Vincent”, and the price is \$39.00. There's no need to include the dollar sign \$ in the amount as we'll add that in our eventual template.

The screenshot shows the Django administration interface for adding a new book. The browser tab is titled "Add book | Django site admin". The address bar shows the URL "127.0.0.1:8000/admin/books/book/add/". The page header includes the Django administration logo and a welcome message for user "wsv". The breadcrumb trail is "Home > Books > Books > Add book". The form has three fields: "Title" with the value "Django for Professionals", "Author" with the value "William S. Vincent", and "Price" with the value "39.00". At the bottom, there are three buttons: "Save and add another", "Save and continue editing", and "SAVE".

Admin - Django for Professionals book

After clicking on the “Save” button it redirects to the main Books page which only shows the title.

The screenshot shows the Django administration interface for the main Books page. The browser tab is titled "Select book to change | Django". The address bar shows the URL "127.0.0.1:8000/admin/books/book/". The page header includes the Django administration logo and a welcome message for user "wsv". The breadcrumb trail is "Home > Books > Books". A green success message at the top states: "The book 'Django for Professionals' was added successfully." Below this, there is a section titled "Select book to change" with an "ADD BOOK +" button. The "Action:" dropdown is set to "-----" and the "Go" button is visible. Below the "Action:" dropdown, there is a table with two rows: "BOOK" and "Django for Professionals". The "Django for Professionals" row is selected. At the bottom, it says "1 book".

Admin Books Page

Let's update the `books/admin.py` file to specify which fields we also want displayed.

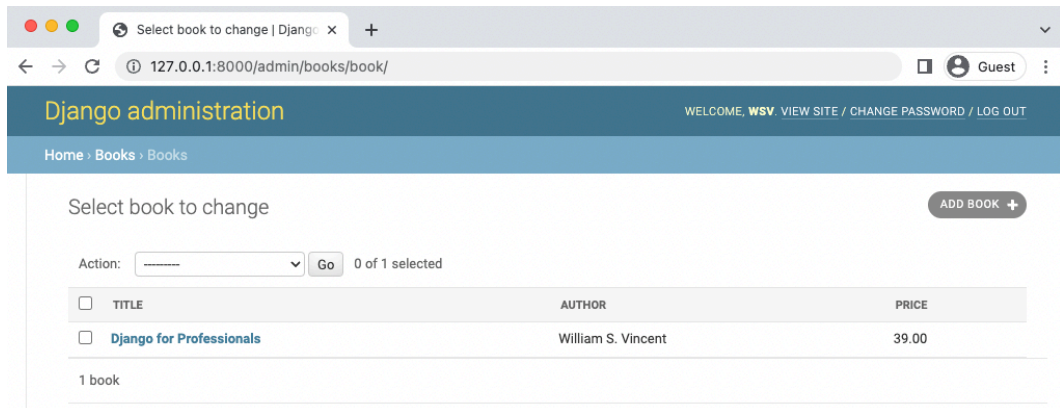
Code

```
# books/admin.py
from django.contrib import admin
from .models import Book

class BookAdmin(admin.ModelAdmin):
    list_display = ("title", "author", "price",)

admin.site.register(Book, BookAdmin)
```

Then refresh the page.

**Admin Books List Page**

Now that our database model is complete we need to create the necessary views, URLs, and templates so we can display the information on our web application. Where to start is always a question and a confusing one at that for developers.

Personally I often start with the URLs, then the Views, and the Templates.

URLs

We need to update two `urls.py` files. The first one is `django_project/urls.py`. Add the new path for the books app.

Code

```
# django_project/urls.py
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("admin/", admin.site.urls),
    # User management
    path("accounts/", include("allauth.urls")),
    # Local apps
    path("", include("pages.urls")),
    path("books/", include("books.urls")), # new
]
```

Now create a `books/urls.py` file in your text editor for our books app URLs paths. We'll use the empty string, `""` so all books app URLs will start at `books/` based on the URL path just set in `django_project/urls.py`. The view it references, `BookListView`, has yet to be created and it will have the URL name of `book_list`.

Code

```
# books/urls.py
from django.urls import path

from .views import BookListView

urlpatterns = [
    path("", BookListView.as_view(), name="book_list"),
]
```

Views

Moving along it is time for that `BookListView` we just referenced in our URLs file. This will rely on the built-in [ListView](#), a Generic Class-Based View provided for common use cases like this. All we must do is specify the proper model and template to be used.

Code

```
# books/views.py
from django.views.generic import ListView

from .models import Book

class BookListView(ListView):
    model = Book
    template_name = "books/book_list.html"
```

Note the template `book_list.html` does not exist yet.

Templates

It is optional to create an app specific folder within our base-level templates directory but it can help especially as number grows in size so we'll create one called `books`.

Shell

```
$ mkdir templates/books/
```

In your text editor create a new file called `templates/books/book_list.html`.

Code

```
<!-- templates/books/book_list.html -->
{% extends "_base.html" %}

{% block title %}Books{% endblock title %}

{% block content %}
    {% for book in object_list %}
        <div>
            <h2><a href="">{{ book.title }}</a></h2>
        </div>
    {% endfor %}
{% endblock content %}
```

At the top we note that this template extends `_base.html` and then wraps our desired code with content blocks. We use the Django Templating Language to set up a simple *for loop* for each book. Note that `object_list` comes from `ListView` and contains all the objects in our view.

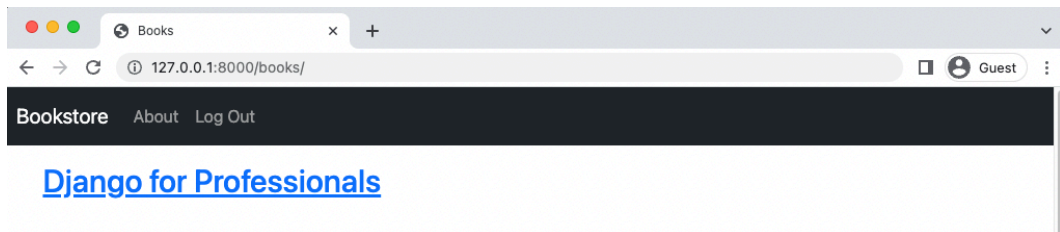
The final step is to spin up and then down our containers to reload the Django `django-project/settings.py` file. Otherwise it won't realize we've made a change and so there will be an error page and in the logs a message about “`ModuleNotFoundError: No module named 'books.urls'`”.

Spin down and then up again our containers.

Shell

```
$ docker-compose down
$ docker-compose up -d
```

In your web browser go to `http://127.0.0.1:8000/books/` and the new books page is visible.



Books Page

object_list

`ListView` relies on `object_list`, as we just saw, but this is far from descriptive. A better approach is to rename it to a **friendlier** name using `context_object_name`.

Update `books/views.py` as follows.

Code

```
# books/views.py
from django.views.generic import ListView

from .models import Book

class BookListView(ListView):
    model = Book
    context_object_name = "book_list" # new
    template_name = "books/book_list.html"
```

And then swap out `object_list` in our template for `book_list`.

Code

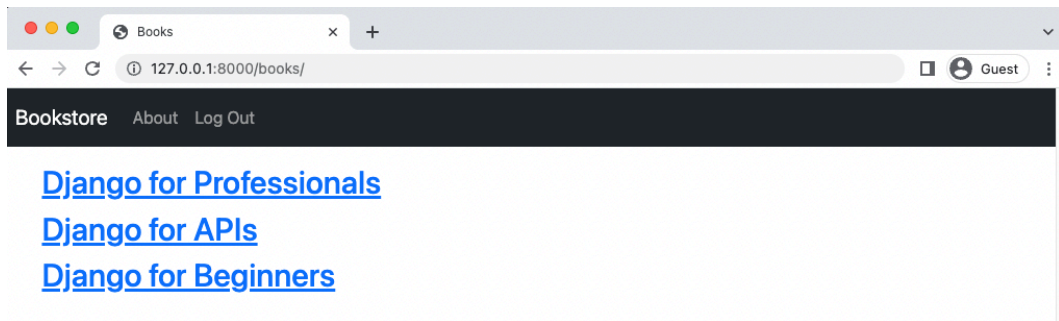
```
<!-- templates/books/book_list.html -->
{% extends "_base.html" %}

{% block title %}Books{% endblock title %}

{% block content %}
    {% for book in book_list %}
        <div>
            <h2><a href="">{{ book.title }}</a></h2>
        </div>
    {% endfor %}
{% endblock content %}
```

Refresh the page and it will still work as before! This technique is especially helpful on larger projects where multiple developers are working on a project. It's hard for a front-end engineer to guess correctly what `object_list` means!

To prove the list view works for multiple items add two more books to the site via the admin. I've added my two other Django books—*Django for APIs* and *Django for Beginners*—which both have “William S. Vincent” as the author and “39.00” as the price.



Three Books

Individual Book Page

Now we can add individual pages for each book by using another Generic Class-Based View called [DetailView](#).

Our process is similar to the Books page and starts with the URL importing `BookDetailView` on the second line and then setting the path to be the primary key of each book which will be represented as an integer `<int:pk>`.

Code

```
# books/urls.py
from django.urls import path

from .views import BookListView, BookDetailView # new

urlpatterns = [
    path("", BookListView.as_view(), name="book_list"),
    path("<int:pk>/", BookDetailView.as_view(), name="book_detail"), # new
]
```

Django automatically adds an [auto-incrementing primary key](#) to our database models. So while we only declared the fields `title`, `author`, and `body` on our `Book` model, under-the-hood Django also added another field called `id`, which is our primary key. We can access it as either `id` or `pk`.

The `pk` for our first book is 1. For the second one it will be 2. And so on. Therefore when we go to the individual entry page for our first book, we can expect that its URL route will be `books/1`.

Now on to the `books/views.py` file where we'll import `DetailView` and create a `BookDetailView` class that also specifies `model` and `template_name` fields.

Code

```
# books/views.py
from django.views.generic import ListView, DetailView # new

from .models import Book

class BookListView(ListView):
    model = Book
    context_object_name = "book_list"
    template_name = "books/book_list.html"

class BookDetailView(DetailView): # new
    model = Book
    template_name = "books/book_detail.html"
```

And finally create the new template file `templates/books/book_detail.html`. It will display all the current fields. We can also showcase the title in the `title` tags so that it appears in the web browser tab.

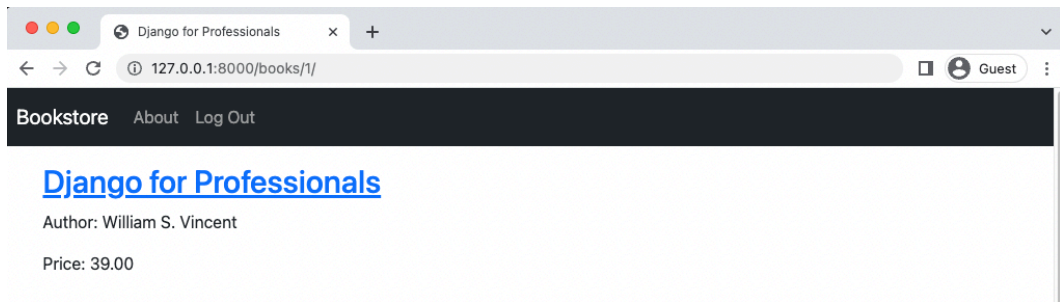
Code

```
<!-- templates/books/book_detail.html -->
{% extends "_base.html" %}

{% block title %}{{ object.title }}{% endblock title %}

{% block content %}
    <div class="book-detail">
        <h2><a href="">{{ object.title }}</a></h2>
        <p>Author: {{ object.author }}</p>
        <p>Price: {{ object.price }}</p>
    </div>
{% endblock content %}
```

In your web browser navigate to `http://127.0.0.1:8000/books/1/` and you'll see a dedicated page for our first book.



Book Detail Page

context_object_name

Just as `ListView` defaults to `object_list` which we updated to be more specific, so too `DetailView` defaults to `object` which we can make more descriptive using `context_object_name`. We'll set it to `book`.

Code

```
# books/views.py
...
class BookDetailView(DetailView):
    model = Book
    context_object_name = "book" # new
    template_name = "books/book_detail.html"
```

Don't forget to update our template too with this change, swapping out `object` for `book` for our three fields.

Code

```
<!-- templates/books/book_detail.html -->
{% extends "_base.html" %}

{% block title %}{{ book.title }}{% endblock title %}

{% block content %}
  <div class="book-detail">
    <h2><a href="">{{ book.title }}</a></h2>
    <p>Author: {{ book.author }}</p>
    <p>Price: {{ book.price }}</p>
  </div>
{% endblock content %}
```

Adding URLs

We want the links on the book list page to point to individual pages. With the [url template tag](#) we can point to `book_detail` – the URL name set in `books/urls.py` – and then pass in the `pk`.

Code

```
<!-- templates/books/book_list.html -->
{% extends "_base.html" %}

{% block title %}Books{% endblock title %}

{% block content %}
  {% for book in book_list %}
    <div>
      <h2><a href="{% url 'book_detail' book.pk %}">{{ book.title }}</a></h2>
    </div>
  {% endfor %}
{% endblock content %}
```

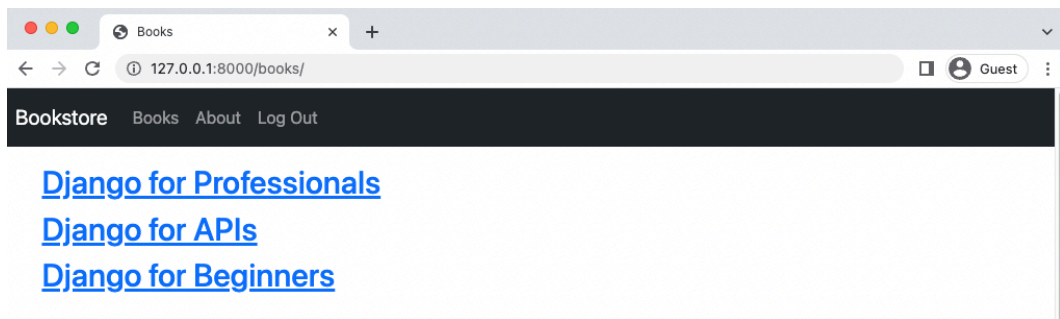
Refresh the book list page at `http://127.0.0.1:8000/books/` and links are now all clickable and direct to the correct individual book page.

As a final step, let's add a navbar link for “Books” so we don't have to type out the full URL each time. The URL name for our book list view, `book_list`, can be used along with the `url` template tag to do this. Here is what the updated code looks like in `templates/_base.html`.

Code

```
<!-- templates/_base.html -->
...
<div class="collapse navbar-collapse" id="navbarCollapse">
  <ul class="navbar-nav me-auto mb-2 mb-md-0">
    <li class="nav-item">
      <a class="nav-link" href="{% url 'book_list' %}">Books</a>
    </li>
    <li class="nav-item">
      <a class="nav-link" href="{% url 'about' %}">About</a>
    </li>
  </ul>
</div>
...
```

Refresh any page on the website and the working “Books” navbar link is now there.



Book Navbar Link

get_absolute_url

One recommended step we haven’t made yet is to add a `get_absolute_url()` method which sets a canonical URL for the model. It is also required when using the `reverse()` function.

Here’s how to add it to our `books/models.py` file. Import `reverse` at the top. Then add the `get_absolute_url` method which will be the reverse of our URL name, `book_detail`, and passes in the `id` as a string.

Code

```
# books/models.py
from django.db import models
from django.urls import reverse # new

class Book(models.Model):
    title = models.CharField(max_length=200)
    author = models.CharField(max_length=200)
    price = models.DecimalField(max_digits=6, decimal_places=2)

    def __str__(self):
        return self.title

    def get_absolute_url(self): # new
        return reverse("book_detail", args=[str(self.id)])
```

Then we can update the templates. Currently our `a href` link is using `{% url 'book_detail' book.pk %}`. However we can instead use `get_absolute_url` directly which already has the `pk` passed in.

Code

```
<!-- templates/books/book_list.html -->
{% extends '_base.html' %}

{% block title %}Books{% endblock title %}

{% block content %}
    {% for book in book_list %}
        <div>
            <h2><a href="{ book.get_absolute_url }}">{{ book.title }}</a></h2>
        </div>
    {% endfor %}
{% endblock content %}
```

There's no need to use the `url` template tag now for the link. Instead there is one canonical reference in the `books/models.py` file. This is a cleaner approach and should be used whenever you need individual pages for an object.

Primary Keys vs. IDs

It can be confusing whether to use a primary key (PK) or an ID in a project, especially since Django's `DetailView` treats them interchangeably. However there is a subtle difference.

The `id` is a model field automatically set by Django internally to auto-increment. So the first book has an `id` of 1, the second entry of 2, and so on. This is also, by default, treated as the primary key `pk` of a model.

However it's possible to manually change what the primary key is for a model. It doesn't have to be `id`, but could be something like `object_id` depending on the use case. Additionally Python has a built-in `id()` object which can sometimes cause confusion and/or bugs.

By contrast the primary key `pk` refers to the primary key field of a model so you're safer using `pk` when in doubt. And in fact in the next section we will update the `id` of our model!

Slugs vs. UUIDs

Using the `pk` field in the URL of our `DetailView` is quick and easy, but not ideal for a real-world project. The `pk` is currently the same as our auto-incrementing `id`. Among other concerns, it tells a potential hacker *exactly* how many records you have in your database; it tells them exactly what the `id` is which can be used in a potential attack; and there can be synchronization issues if you have multiple front-ends.

There are two alternative approaches. The first is called a “slug,” a newspaper term for a short label for something that is often used in URLs. For example, in our example of “Django for Professionals” its slug could be `django-for-professionals`. There's even a `SlugField` model field that can be used and either added when creating the `title` field by hand or auto-populated upon save. The main challenge with slugs is handling duplicates, though this can be solved by adding random strings or numbers to a given slug field. The synchronization issue remains though.

A better approach is to use a **UUID (Universally Unique Identifier)** which Django now supports via a dedicated `UUIDField`.

Let's implement a UUID now by adding a new field to our model and then updating the URL path.

Import `uuid` at the top and then update the `id` field to actually be a `UUIDField` that is now the primary key. We also use `uuid4` for the encryption. This allows us to use `DetailView` which requires either a slug or pk field; it won't work with a `UUID` field without significant modification.

Code

```
# books/models.py
import uuid # new
from django.db import models
from django.urls import reverse

class Book(models.Model):
    id = models.UUIDField( # new
        primary_key=True,
        default=uuid.uuid4,
        editable=False)
    title = models.CharField(max_length=200)
    author = models.CharField(max_length=200)
    price = models.DecimalField(max_digits=6, decimal_places=2)

    def __str__(self):
        return self.title

    def get_absolute_url(self):
        return reverse("book_detail", args=[str(self.id)])
```

In the URL path swap out `int` for `uuid` in the detail view.

Code

```
# books/urls.py
from django.urls import path

from .views import BookListView, BookDetailView

urlpatterns = [
    path("", BookListView.as_view(), name="book_list"),
    path("<uuid:pk>", BookDetailView.as_view(), name="book_detail"), # new
]
```

But now we are faced with a problem: there are existing book entries, three in fact, with their own ids as well as related migration files that use them. Creating a new migration like this [causes](#)

real problems. The simplest approach, which we will use, is the most destructive: to simply delete old books migrations and start over.

Shell

```
$ docker-compose exec web rm -r books/migrations
$ docker-compose down
```

One last issue is that we are also persisting our PostgreSQL database via a volume mount that still has records to the older `id` fields. You can see this with the `docker volume ls` command.

Shell

```
$ docker volume ls
DRIVER          VOLUME NAME
local           books_postgres_data
```

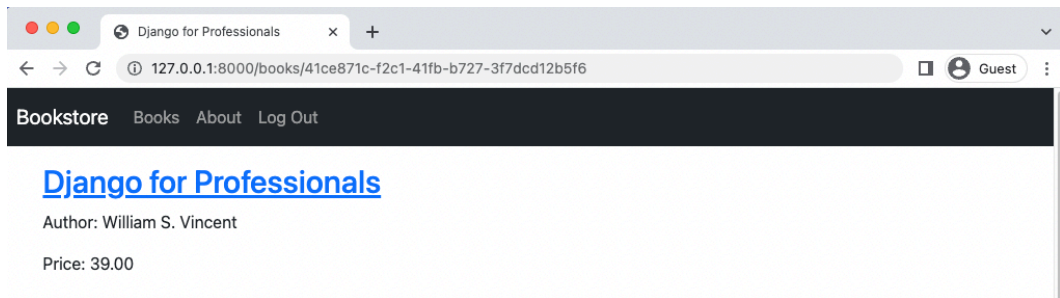
The simplest approach is again to simply delete the volume and start over with Docker. As we're early enough in the project we'll take this route; a more mature project would require considering a more complex approach.

The steps involve starting up our web and db containers; adding a new initial migration file for the books app, applying all updates with `migrate`, and then creating a superuser account again.

Shell

```
$ docker volume rm books_postgres_data
$ docker-compose up -d
$ docker-compose exec web python manage.py makemigrations books
$ docker-compose exec web python manage.py migrate
$ docker-compose exec web python manage.py createsuperuser
```

Now go into admin and add the three books again. If you then navigate to the main books page and click on an individual book you'll be taken to a new detail page with a UUID in the URL.



Django for Professionals book UUID

By removing the volume we also lost our various `testuser` accounts but that's ok. We can recreate them as needed going forward.

Tests

We need to test our model and views now. We want to ensure that the `Books` model works as expected, including its `str` representation. And we want to test both `ListView` and `DetailView`. Here's what sample tests look like in the `books/tests.py` file.

Code

```
# books/tests.py
from django.test import TestCase
from django.urls import reverse

from .models import Book

class BookTests(TestCase):

    @classmethod
    def setUpTestData(cls):
        cls.book = Book.objects.create(
            title="Harry Potter",
            author="JK Rowling",
            price="25.00",
        )

    def test_book_listing(self):
        self.assertEqual(f"{self.book.title}", "Harry Potter")
```



```
self.assertEqual(f"{self.book.author}", "JK Rowling")
self.assertEqual(f"{self.book.price}", "25.00")

def test_book_list_view(self):
    response = self.client.get(reverse("book_list"))
    self.assertEqual(response.status_code, 200)
    self.assertContains(response, "Harry Potter")
    self.assertTemplateUsed(response, "books/book_list.html")

def test_book_detail_view(self):
    response = self.client.get(self.book.get_absolute_url())
    no_response = self.client.get("/books/12345/")
    self.assertEqual(response.status_code, 200)
    self.assertEqual(no_response.status_code, 404)
    self.assertContains(response, "Harry Potter")
    self.assertTemplateUsed(response, "books/book_detail.html")
```

We import `TestCase` and introduce the `setUpTestData` method to add a sample book to test. Using `setUpTestData` often dramatically increases the speed of your tests because the initial data is created once rather than each time for each unit test.

The first unit test, `test_book_listing`, checks that both its string representation and content are correct. Then we use `test_book_list_view` to confirm that our homepage returns a 200 HTTP status code, contains our body text, and uses the correct `books/book_list.html` template. Finally, `test_book_detail_view` tests that our detail page works as expected and that an incorrect page returns a 404. It's always good both to test that something **does** exist and that something incorrect **doesn't** exist in your tests.

Go ahead and run these tests now. They should all pass.

Shell

```
$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
```

```
.....
```

```
-----
Ran 17 tests in 0.208s
```

```
OK
```

```
Destroying test database for alias 'default'...
```

Git

We've done a lot of work in this chapter so add it all to version control now with Git by adding new files and adding a commit message.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch11'
```

The official source code for this chapter is [available on Github](#) for reference.

Conclusion

We're at the end of quite a long chapter, but the architecture of our Bookstore project is now much clearer. We've added a `books` model, learned how to change the URL structure, and switched to the much more secure UUID pattern.

In the next chapter we'll learn about foreign key relationships and add a reviews option to our project.

Chapter 12: Reviews App

In this chapter we'll add a `reviews` app so that readers can leave reviews of their favorite books. It gives us a chance to discuss foreign keys, app structure, and dive into forms.

Foreign Keys

We've already used a foreign key with our user model, but didn't have to think about it. Now we do! Fundamentally a database table can be thought of as similar to a spreadsheet with rows and columns. There needs to be a *primary key* field that is unique and refers to each record. In the last chapter we changed that from `id` to a `UUID`, but one still exists!

This matters when we want to link two tables together. For example, our `Books` model will link to a `Reviews` model since each review has to be connected to a relevant book. This implies a foreign key relationship.

There are three possible types of foreign key relationships:

- [One-to-one](#)
- [One-to-many](#)
- [Many-to-many](#)

A one-to-one relationship is the simplest kind. An example would be a table of people's names and a table of social security numbers. Each person has only **one** social security number and each social security number is linked to only **one** person.

In practice one-to-one relationships are rare. It's unusual for both sides of a relationship to only be matched to one counterpart. Some other examples though would be country-flag or person-passport.

A one-to-many relationship is more common and is the [default foreign key](#) setting within Django. For example, consider a restaurant where **one** customer can place **many** orders.

It's also possible to have a [ManyToManyField](#) relationship. Let's consider a list of books and a list of authors: each book could have more than one author and each author can write more than one book. That's a many-to-many relationship. Just as with the previous two examples you need a linked Foreign Key field to connect the two lists. Additional examples include doctors and patients (every doctor sees multiple patients and vice versa) or employees and tasks (each employee has multiple tasks while each task is worked on by multiple employees).

Database design is a fascinating, deep topic that is both an art and a science. As the number of tables grow in a project over time it is almost inevitable that a refactoring will need to occur to address issues around inefficiency, bloat, and outright errors. [Normalization](#) is the process of structuring a relational database though far beyond the scope of this book.

Reviews model

Coming back to our basic reviews app, the first consideration is what type of foreign key relationship will there be. If we are going to link a user to a review, then it is a straightforward one-to-many relationship. However it could also be possible to link books to reviews which would be many-to-many. The “correct” choice quickly becomes somewhat subjective and certainly dependent upon the particular needs of the project.

In this project we'll treat the reviews app as a one-to-many between authors and reviews as it's the simpler approach.

Here again we face a choice around how to design our project. Do we add the `Reviews` model within our existing `books/models.py` file or create a dedicated `reviews` app that we then link to? Let's start by adding a `Reviews` model to the `books` app.

Code

```
# books/models.py
import uuid
from django.contrib.auth import get_user_model  # new
from django.db import models
from django.urls import reverse

class Book(models.Model):
    ...

class Review(models.Model):  # new
    book = models.ForeignKey(
        Book,
        on_delete=models.CASCADE,
        related_name="reviews",
    )
    review = models.CharField(max_length=255)
    author = models.ForeignKey(
        get_user_model(),
        on_delete=models.CASCADE,
    )

    def __str__(self):
        return self.review
```

At the top, under imports include `get_user_model`, which is needed to refer to our CustomUser model, then create a dedicated Review model. The book field is the one-to-many foreign key that links Book to Review and we're following the standard practice of naming it the same as the linked model. The review field contains the actual content which perhaps could be a [TextField](#) depending on how much space you want to provide for review length! For now, we'll force reviews to be short at 255 characters or less. And then we'll also link to the author field to auto-populate the current user with the review.

For all many-to-one relationships such as a ForeignKey we must also specify an `on_delete` option. We also explicitly set the `related_name` to make it easier to follow the foreign key relationship "backwards" in the future on queries. Note that this name **must be unique** to avoid future problems. And lastly using `get_user_model` to reference our custom user model.

Create a new migrations file for our changes and then run migrate to apply them.

Shell

```
$ docker-compose exec web python manage.py makemigrations books
Migrations for 'books':
  books/migrations/0002_review.py
    - Create model Review
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, books, contenttypes, sessions, si\
tes
Running migrations:
  Applying books.0002_review... OK
```

Admin

For the reviews app to appear in the admin we need to update `books/admin.py` substantially by adding the Review model and specifying a display of [TabularInline](#).

Code

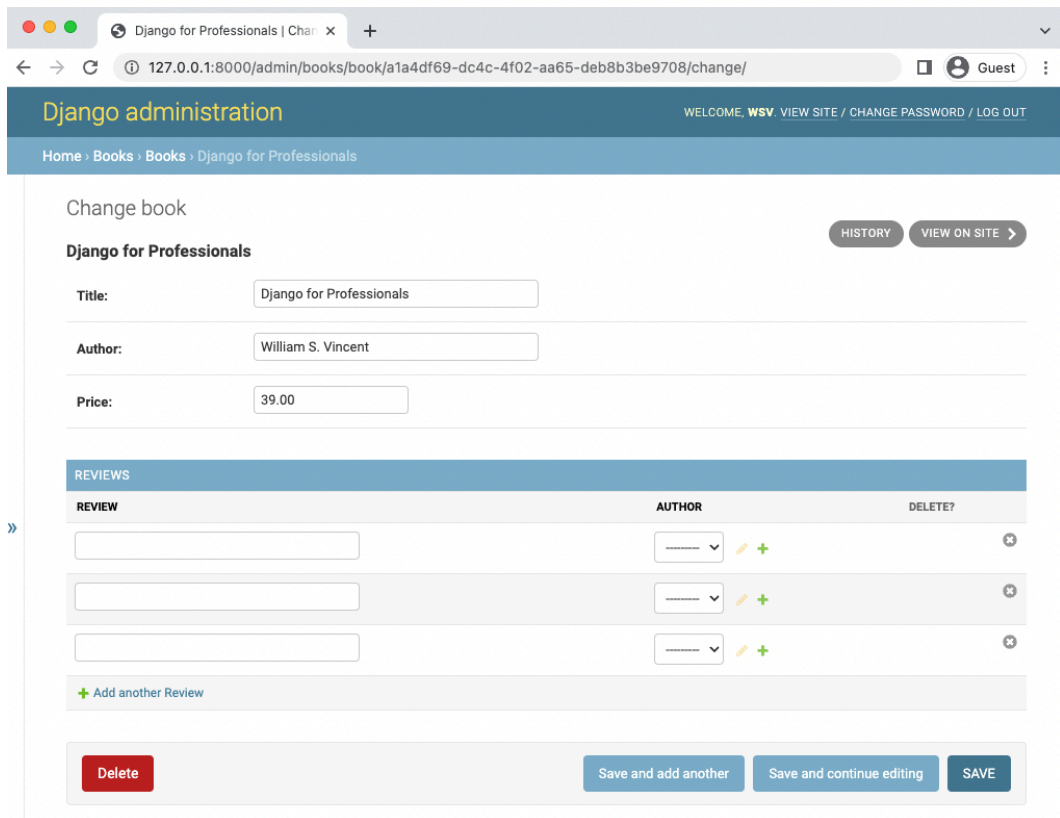
```
# books/admin.py
from django.contrib import admin
from .models import Book, Review

class ReviewInline(admin.TabularInline):
    model = Review

class BookAdmin(admin.ModelAdmin):
    inlines = [
        ReviewInline,
    ]
    list_display = ("title", "author", "price",)

admin.site.register(Book, BookAdmin)
```

Now navigate to the books section at `http://127.0.0.1:8000/admin/books/book/` and then click on any of the books to see the reviews visible on the individual book page.



Django for Professionals | Change

127.0.0.1:8000/admin/books/book/a1a4df69-dc4c-4f02-aa65-deb8b3be9708/change/ Guest

Django administration

WELCOME, **WSV** [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#)

Home » Books » Books » Django for Professionals










Change book

Django for Professionals [HISTORY](#) [VIEW ON SITE](#)

Title:

Author:

Price:

REVIEWS		
REVIEW	AUTHOR	DELETE?
<input type="text"/>	<input type="text" value="William S. Vincent"/>  	
<input type="text"/>	<input type="text" value="William S. Vincent"/>  	
<input type="text"/>	<input type="text" value="William S. Vincent"/>  	

[+ Add another Review](#)

[Delete](#) [Save and add another](#) [Save and continue editing](#) [SAVE](#)

Django for Professionals Admin Reviews

We're limited to reviews by existing users at this point, although we have previously created a `testuser@email.com` that was deleted when we removed the database volume mount in the previous chapter. There are two options for adding this account: we could go to the main site and use the "Sign Up" link or we can add it directly from the admin. Let's do the latter.

From the Users section on the Admin homepage click on the "+ Add" button. Add a new user called `testuser` and a password. Click the "Save" button.

The screenshot shows a web browser window with the address bar displaying `127.0.0.1:8000/admin/accounts/customuser/add/`. The page title is "Django administration" and the user is logged in as "Guest". The breadcrumb trail is "Home > Accounts > Users > Add user".

The main heading is "Add user". Below it, a message states: "First, enter a username and password. Then, you'll be able to edit more user options."

The form contains three fields:

- Username:** A text input field containing "testuser". Below it, a note reads: "Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only."
- Password:** A password input field showing eight dots. Below it, four validation messages are listed:
 - Your password can't be too similar to your other personal information.
 - Your password must contain at least 8 characters.
 - Your password can't be a commonly used password.
 - Your password can't be entirely numeric.
- Password confirmation:** A password input field showing eight dots. Below it, a note reads: "Enter the same password as before, for verification."

At the bottom of the form, there are three buttons: "Save and add another", "Save and continue editing", and "SAVE".

Admin testuser

Then on the next page add `testuser@email.com` as the email address. Did you notice the the user's password is encrypted now? Django *does not* store raw passwords which means even as a superuser we cannot see individual user passwords. We can change the password to something else but we can't just copy and paste user passwords.

Scroll down to the bottom of the page and click the "Save" button.

The screenshot shows a web browser window with the address bar displaying `127.0.0.1:8000/admin/accounts/customuser/2/change/`. The page title is "Django administration" and the user is logged in as "Guest". The breadcrumb trail is "Home > Accounts > Users > testuser". A green success message at the top states: "The user 'testuser' was added successfully. You may edit it again below." The main section is titled "Change user" and shows the user "testuser". There is a "HISTORY" button. The "Username" field is filled with "testuser". The "Password" field is filled with a long alphanumeric string. Below the password field, there is a section for "Personal info" with fields for "First name", "Last name", and "Email address". The "Email address" field is filled with "testuser@email.com". At the bottom, there is a section for "Permissions".

testuser | Change user | Django

127.0.0.1:8000/admin/accounts/customuser/2/change/ Guest

Django administration WELCOME, **WSV** [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#)

Home > Accounts > Users > testuser

✓ The user "testuser" was added successfully. You may edit it again below.

Change user **testuser** [HISTORY](#)

Username:
Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.

Password: **algorithm:** pbkdf2_sha256 **iterations:** 320000 **salt:** esWP0U***** **hash:** NZE7sb*****
Raw passwords are not stored, so there is no way to see this user's password, but you can change the password using [this form](#).

Personal info

First name:

Last name:

Email address:

Permissions

Admin testuser

Ok, finally, we can add reviews to the “Django for Professionals” book using `testuser`. Navigate back to the Books section and click on the correct book. Write two reviews and as `AUTHOR` make sure to select `testuser`.

Change book

Django for Professionals HISTORY VIEW ON SITE >

Title:

Author:

Price:

REVIEW	AUTHOR	DELETE?
<input type="text" value="I loved it!"/>	testuser	
<input type="text" value="Very informative."/>	testuser	
<input type="text"/>		

[Add another Review](#)

Delete Save and add another Save and continue editing SAVE

Add Two Reviews

Templates

With the reviews model set it is time to update our templates to display reviews on the individual page for each book. Add a basic “Reviews” section and then loop over all existing reviews. Since this is a foreign key relationship we follow it by using `book.reviews.all`. Then display the review field with `review.review` and the author with `review.author`.

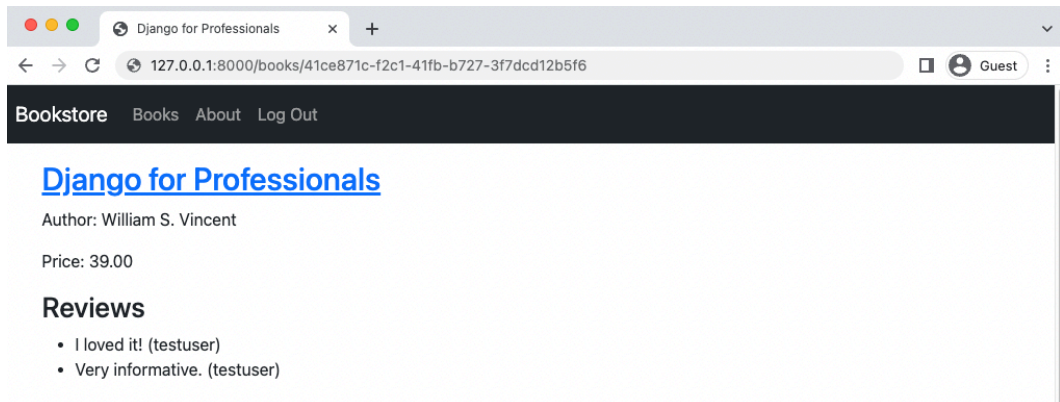
Code

```
# templates/books/book_detail.html
{% extends "_base.html" %}

{% block title %}{ book.title }}{% endblock title %}

{% block content %}
<div class="book-detail">
  <h2><a href="">{{ book.title }}</a></h2>
  <p>Author: {{ book.author }}</p>
  <p>Price: {{ book.price }}</p>
  <div>
    <h3>Reviews</h3>
    <ul>
      {% for review in book.reviews.all %}
      <li>{{ review.review }} ({{ review.author }})</li>
      {% endfor %}
    </ul>
  </div>
</div>
{% endblock content %}
```

That's it! Navigate over to the “Django for Professionals” individual page to see the result. Your url will be different than the one here because we're using a UUID.



Reviews on Detail Page

Tests

Time for tests. We need to create a new user for our review and add a review to the `setUpTestData` method in our test suite. Then we can test that the book object contains the correct review.

This involves importing `get_user_model` as well as adding the `Review` model at the top. We can use `create_user` to make a new user called `reviewuser` and then a review object that is linked to our single book object. Finally under `test_book_detail_view` we can add an additional `assertContains` test to the response object.

Code

```
# books/tests.py
from django.contrib.auth import get_user_model  # new
from django.test import TestCase
from django.urls import reverse

from .models import Book, Review  # new

class BookTests(TestCase):

    @classmethod
    def setUpTestData(cls):
        cls.user = get_user_model().objects.create_user(  # new
            username="reviewuser",
            email="reviewuser@email.com",
            password="testpass123",
        )

        cls.book = Book.objects.create(
            title="Harry Potter",
            author="JK Rowling",
            price="25.00",
        )

        cls.review = Review.objects.create(  # new
            book=cls.book,
            author=cls.user,
            review="An excellent review",
        )

    def test_book_listing(self):
```

```

self.assertEqual(f"{self.book.title}", "Harry Potter")
self.assertEqual(f"{self.book.author}", "JK Rowling")
self.assertEqual(f"{self.book.price}", "25.00")

def test_book_list_view(self):
    response = self.client.get(reverse("book_list"))
    self.assertEqual(response.status_code, 200)
    self.assertContains(response, "Harry Potter")
    self.assertTemplateUsed(response, "books/book_list.html")

def test_book_detail_view(self):
    response = self.client.get(self.book.get_absolute_url())
    no_response = self.client.get("/books/12345/")
    self.assertEqual(response.status_code, 200)
    self.assertEqual(no_response.status_code, 404)
    self.assertContains(response, "Harry Potter")
    self.assertContains(response, "An excellent review") # new
    self.assertTemplateUsed(response, "books/book_detail.html")

```

If you run the tests now they all should pass.

Shell

```

$ docker-compose exec web python manage.py test
Creating test database for alias 'default'...
System check identified no issues (0 silenced).
.....

```

```

-----
Ran 17 tests in 0.260s

```

```

OK
Destroying test database for alias 'default'...

```

Git

Add our new code changes to Git and include a commit message for the chapter.

Shell

```
$ git status  
$ git add .  
$ git commit -m 'ch12'
```

The code for this chapter can be found [on the official Github repository](#).

Conclusion

With more time we might update the reviews functionality with a form on the page itself, however this means AJAX calls using either htmx, jQuery, React, Vue, or another dedicated JavaScript framework. Unfortunately covering that fully is well beyond the scope of this book.

As the project grows it might also make sense to split reviews off into its own dedicated app. Doing so is a very subjective call. In general, keeping things as simple as possible—adding foreign keys within an existing app until it becomes too large to easily understand—is a solid approach.

In the next chapter we will add image uploads to our site so there can be covers for each book.

Chapter 13: File/Image Uploads

We previously configured static assets such as images in Chapter 6, but user-uploaded files, such as book covers, are somewhat different. To start with, Django refers to the former as `static` whereas anything uploaded by a user, whether it be a file or an image, is referred to as `media`.

The process for adding this feature for files or images is similar, but for images the Python image processing library [Pillow](#) must be installed which includes additional features such as basic validation.

Let's install `pillow` using our by-now-familiar pattern of adding it to the `requirements.txt` file.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycopg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
environs[django]==9.5.0
pillow==9.0.1
```

Then stop our Docker container, rebuild the Docker image so it now contains `pillow`, and start up the container up again.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

Media Files

Fundamentally the difference between static and media files is that we can trust the former, but we definitely can't trust the latter by default. There are always [security concerns](#) when dealing

with [user-uploaded content](#). Notably, it's important to *validate all uploaded files* to ensure they are what they say they are. There are a number of nasty ways a malicious actor can attack a website that blindly accepts user uploads.

To start let's add two new configurations to the `django_project/settings.py` file. By default `MEDIA_URL` and `MEDIA_ROOT` are both empty and not displayed so we need to configure them:

- [MEDIA_ROOT](#) is the absolute file system path to the directory for user-uploaded files
- [MEDIA_URL](#) is the URL we can use in our templates for the files

We can add both of these settings after `STATICFILES_STORAGE` near the bottom of the `django_project/settings.py` file. We'll use the common convention of calling both `media`. Don't forget to include the trailing slash `/` for `MEDIA_URL`!

Code

```
# django_project/settings.py
MEDIA_URL = "/media/" # new
MEDIA_ROOT = BASE_DIR / "media" # new
```

Next add a new directory called `media` and a subdirectory called `covers` within it.

Shell

```
$ mkdir media
$ mkdir media/covers
```

And finally, since user-uploaded content is assumed to exist in a production context, to see `media` items locally we need to update `django_project/urls.py` to show the files locally. This involves importing both `settings` and `static` at the top and then adding an additional line at the bottom.

Code

```
# django_project/urls.py
from django.conf import settings # new
from django.conf.urls.static import static # new
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("admin/", admin.site.urls),
    # User management
    path("accounts/", include("allauth.urls")),
    # Local apps
    path("", include("pages.urls")),
    path("books/", include("books.urls")),
] + static(
    settings.MEDIA_URL, document_root=settings.MEDIA_ROOT
) # new
```

Models

With our generic media configuration out of the way we can now turn to our models. To store these images we'll use Django's [ImageField](#) which comes with some basic image processing validation included.

The name of the field is `cover` and we specify the location of the uploaded image will be in `MEDIA_ROOT/covers` (the `MEDIA_ROOT` part is implied based on our earlier `settings.py` config).

Code

```
# books/models.py
class Book(models.Model):
    id = models.UUIDField(
        primary_key=True,
        default=uuid.uuid4,
        editable=False)
    title = models.CharField(max_length=200)
    author = models.CharField(max_length=200)
    price = models.DecimalField(max_digits=6, decimal_places=2)
    cover = models.ImageField(upload_to="covers/") # new

    def __str__(self):
        return self.title

    def get_absolute_url(self):
        return reverse("book_detail", args=[str(self.id)])
```

If we wanted to allow uploads of a regular file rather than an image file the only difference could be to change `ImageField` to `FileField`.

Since we've updated the model it's time to create a migrations file.

Shell

```
$ docker-compose exec web python manage.py makemigrations books
You are trying to add a non-nullable field 'cover_image' to book
without a default; we can't do that (the database needs something to populate
existing rows).
Please select a fix:
  1) Provide a one-off default now (will be set on all existing rows with a
    null value for this column)
  2) Quit, and let me add a default in models.py
Select an option:
```

Oops! What happened? We're adding a new database field, but we already have three entries in our database for each book. Yet we failed to set a default value for `cover`.

To fix this type 2 to quit. We'll add a [blank](#) field set to `True` for existing images.

Code

```
# books/models.py
cover = models.ImageField(upload_to="covers/", blank=True) # new
```

It's common to see `blank` and `null` used together to set a default value on a field. A gotcha is that the *field type* – `ImageField` vs. `CharField` and so on – dictates how to use them properly so closely read the documentation for future use.

Now we can create a migrations file without errors.

Shell

```
$ docker-compose exec web python manage.py makemigrations books
Migrations for 'books':
  books/migrations/0003_book_cover.py
    - Add field cover to book
```

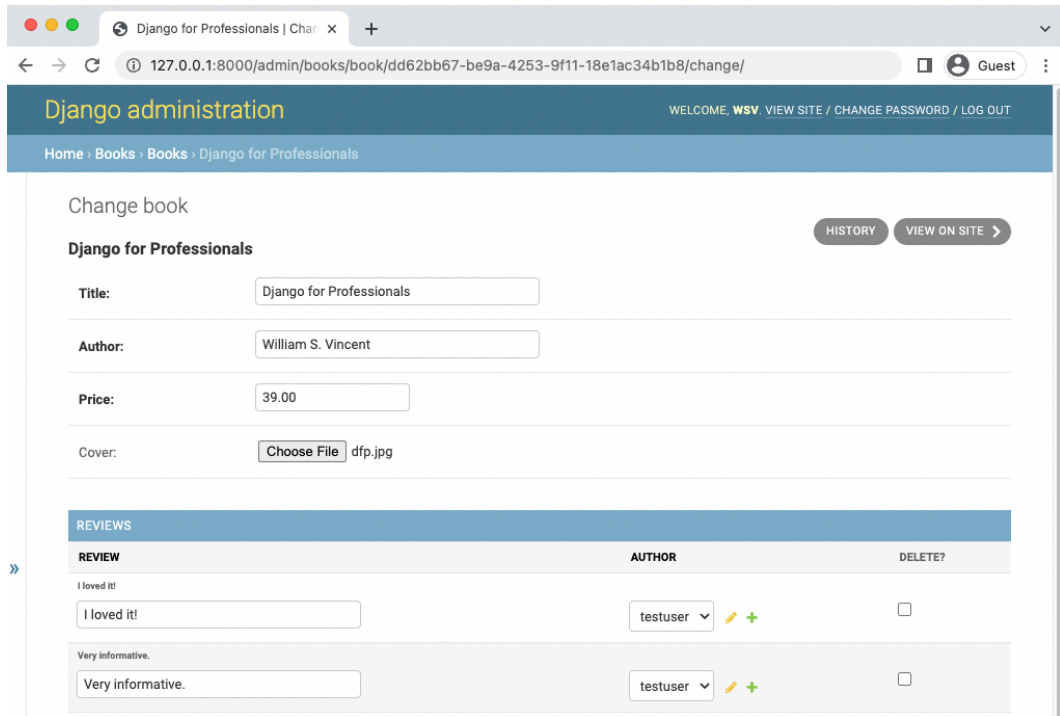
And then apply the migration to our database.

Shell

```
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, books, contenttypes, sessions, si\
tes
Running migrations:
  Applying books.0003_book_cover... OK
```

Admin

We're in the home stretch now! Navigate over to the admin and the entry for the book "Django for Professionals." The `cover` field is visible already and we already have a copy of it locally within `static/images/cover_40.png` so use that file for the upload and then click the "Save" button in bottom right.



Django administration

WELCOME, wsv. [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#)

Home » Books » Books » Django for Professionals

Change book

Django for Professionals [HISTORY](#) [VIEW ON SITE](#)





Title:

Author:

Price:

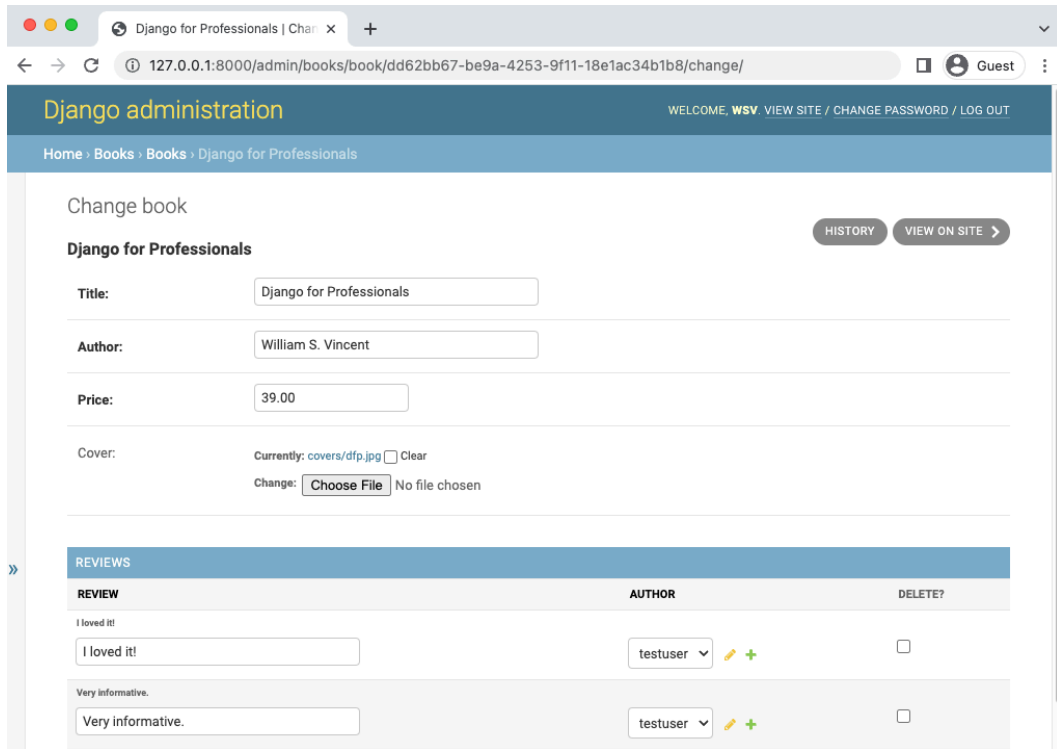
Cover: dfp.jpg

REVIEWS

REVIEW	AUTHOR	DELETE?
<input type="text" value="I loved it!"/>	<input type="text" value="testuser"/>  	<input type="checkbox"/>
<input type="text" value="Very informative."/>	<input type="text" value="testuser"/>  	<input type="checkbox"/>

Admin add cover

This will redirect back to the main Books section. Click on the link again for “Django for Professionals” and we can see it currently exists in our desired location of `covers/`.



Django administration WELCOME, **WSV** [VIEW SITE](#) / [CHANGE PASSWORD](#) / [LOG OUT](#)

Home › Books › Books › Django for Professionals

Change book





Django for Professionals [HISTORY](#) [VIEW ON SITE](#)

Title:

Author:

Price:

Cover: Currently: [covers/dfp.jpg](#) ☐ Clear
Change: No file chosen

REVIEWS		
REVIEW	AUTHOR	DELETE?
I loved it!	testuser  	<input type="checkbox"/>
Very informative.	testuser  	<input type="checkbox"/>

Admin with cover

Template

OK, final step. Let's update our template to display the book cover on the individual page. The route will be `book.cover.url` pointing to the location of the cover in our file system.

Here's what the updated `book_detail.html` file looks like with this one line change above the title.

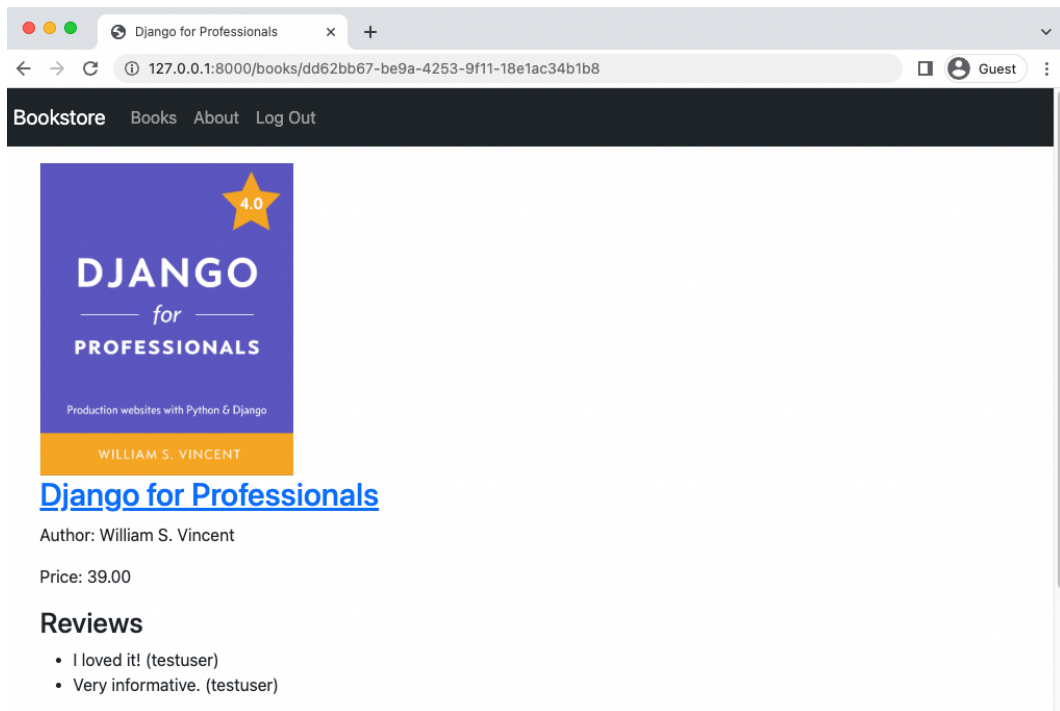
Code

```
# templates/books/book_detail.html
{% extends "_base.html" %}

{% block title %}{{ book.title }}{% endblock title %}

{% block content %}
<div class="book-detail">
  
  <h2><a href="">{{ book.title }}</a></h2>
  <p>Author: {{ book.author }}</p>
  <p>Price: {{ book.price }}</p>
  <div>
    <h3>Reviews</h3>
    <ul>
      {% for review in book.reviews.all %}
      <li>{{ review.review }} ({{ review.author }})</li>
      {% endfor %}
    </ul>
  </div>
</div>
{% endblock content %}
```

If you now visit the page for “Django for Professionals” you’ll see the cover image proudly there!



Cover image

One potential gotcha is that our template now expects a cover to be present. If you navigate to either of the two other books, for which we have not added a cover, you'll see the following `ValueError` message which is quite descriptive.

ValueError at /books/1aebb3b8-7796-4cab-9863-cd673c641946

The 'cover' attribute has no file associated with it.

Request Method: GET
 Request URL: http://127.0.0.1:8000/books/1aebb3b8-7796-4cab-9863-cd673c641946
 Django Version: 4.0.4
 Exception Type: ValueError
 Exception Value: The 'cover' attribute has no file associated with it.
 Exception Location: /usr/local/lib/python3.10/site-packages/django/db/models/fields/files.py, line 40, in _require_file
 Python Executable: /usr/local/bin/python
 Python Version: 3.10.4
 Python Path: ['/code',
 '/usr/local/lib/python3.10.zip',
 '/usr/local/lib/python3.10',
 '/usr/local/lib/python3.10/lib-dynload',
 '/usr/local/lib/python3.10/site-packages']
 Server time: Wed, 18 May 2022 14:03:29 +0000

Error during template rendering

In template /code/templates/books/book_detail.html, error at line 7

The 'cover' attribute has no file associated with it.

```

1 {% extends "_base.html" %}
2
3 {% block title %}{ book.title %}{% endblock title %}
4
5 {% block content %}
6   <div class="book-detail">
7     
8     <h2><a href="{ book.title }">{ book.title }</a></h2>
9     <p>Author: { book.author }</p>
10    <p>Price: { book.price }</p>

```

Cover image error

We must add some basic logic to our template so that if a cover is not present the template doesn't look for it! This can be done using an `if` statement that checks for `book.cover` and displays it if it exists.

Code

```

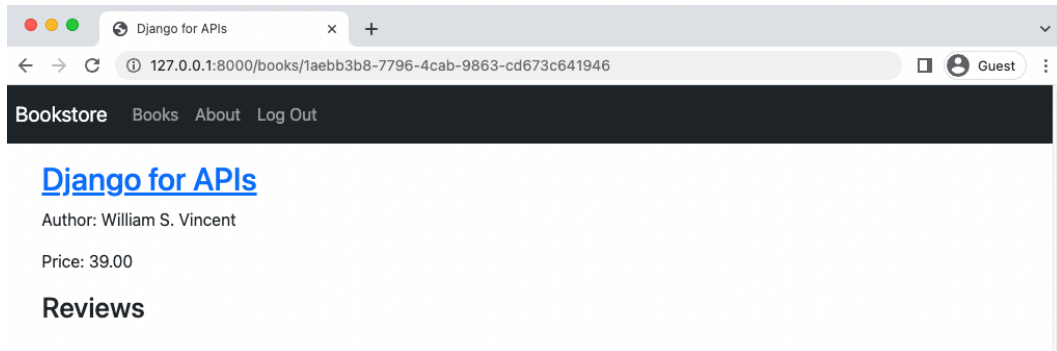
# templates/books/book_detail.html
{% extends "_base.html" %}

{% block title %}{ book.title %}{% endblock title %}

{% block content %}
<div class="book-detail">
  {% if book.cover %}
    
  {% endif %}
  <h2><a href="{ book.title }">{ book.title }</a></h2>
  ...

```


If you refresh either book page now you'll see they display the correct page albeit without a cover.



DFA No Error

django-storages

There are several steps that a truly production website could take but are beyond the current scope of this book. The most important is storing all media files on a dedicated CDN (Content Delivery Network) rather than on our own server. Unlike static files, which the developer controls and can trust, media files are user-generated and should always be treated with caution. The popular third-party package [django-storages](#) allows for storing Django media files on a service like Amazon's S3.

Furthermore the hosting service we will be using later on, Heroku, has an [ephemeral file system](#). Each internal dyno boots with a clean copy of the file system from the most recent deploy. Static files are located on the file system; media files are not. As a result, in production media files will not remain with Heroku. Using `django-storages` is therefore basically mandatory alongside Heroku and will be mentioned again in the deployment chapter.

Next Steps

Additional steps could include extra validations on the image-uploading form to ensure that only a normal, safe image was able to be added. We could add dedicated create/edit/delete forms for the creation of books and cover image. Tests would be nice to have here too although they would

be primarily focused on the form validation section not the basic image-uploading via the admin. Again this is an area that can become quite complex, but is worthy of further study.

The last recommendation is to look at the third-party [django-cleanup](#) package which automatically deletes old files. It can be quite handy.

Git

Make sure to create a new Git commit for the changes in this chapter.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch13'
```

As always you can compare your code against the [official source code on Github](#).

Conclusion

This chapter demonstrated how to add user files to a project. In practice it is straightforward, but the additional layer of security concerns makes it an area worthy of focus at scale.

In the next chapter we will add permissions to our site to lock it down.

Chapter 14: Permissions

Currently there are no permissions set on our Bookstore project. Any user, even one not logged in, can visit any page and perform any available action. While this is fine for prototyping, implementing a robust permissions structure is a must before deploying a website to production.

Django comes with [built-in authorization options](#) for locking down pages to either logged in users, specific groups, or users with the proper individual permission.

Logged-In Users Only

Confusingly there are multiple ways to add even the most basic permission: restricting access only to logged-in users. It can be done in a [raw way](#) using the `login_required()` decorator, or since we are using class-based views so far via the [LoginRequired mixin](#).

Let's start by limiting access to the Books pages only to logged-in users. There is a link for it in the navbar so this is not the case of a user accidentally finding a URL (which also can happen); in this case the URL is quite public.

First import `LoginRequiredMixin` at the top which we will then add to our `BookListView` class. It is important that `LoginRequiredMixin` come *before* `ListView` in order to work properly. Mixins are powerful but can be a little tricky in practice. As the official docs note, [“not all mixins can be used together, and not all generic class based views can be used with all other mixins..”](#)

The second update is adding a `login_url` for the user to be redirected to. This is the URL name for log in which, since we're using `django-allauth` is `account_login`. If we were using the traditional Django authentication system then this link would be called simply `login`.

The structure for `BookDetailView` is the same: add `LoginRequiredMixin` *before* `DetailView` and a `login_url` route as well.

Code

```
# books/views.py
from django.contrib.auth.mixins import LoginRequiredMixin # new
from django.views.generic import ListView, DetailView

from .models import Book

class BookListView(LoginRequiredMixin, ListView): # new
    model = Book
    context_object_name = "book_list"
    template_name = "books/book_list.html"
    login_url = "account_login" # new

class BookDetailView(LoginRequiredMixin, DetailView): # new
    model = Book
    context_object_name = "book"
    template_name = "books/book_detail.html"
    login_url = "account_login" # new
```

And that's it! If you now log out of your account and click on the “Books” link it will automatically redirect you to the Log In page. However if you are logged in, the Books page loads normally. Even if you somehow knew the UUID of a specific book page you'll *still* be redirected to the Log In page!

Permissions

Django comes with a basic [permissions system](#) that is controlled through the Django admin. To demonstrate it we need to create a new user account. Navigate back to the Admin homepage and then click on “+ Add” next to Users.

We'll call this new user `special` and set a password of `testpass123`. Click on the “Save” button. The second page allows us to set an “Email address” to `special@email.com`. Scrolling down further on the page to the bottom there are options to set Groups as well as User permissions. This is a long list of defaults Django provides. For now we won't use them since we'll create a custom permission in the next section so just click on the “Save” button in the lower right corner so that our email address is updated for the user account.

Custom Permissions

Setting [custom permissions](#) is a much more common occurrence in a Django project. We can set them via the `Meta` class on our database models.

For example, let's add a special status so that an author can read all books. In other words they have access to the `DetailView`. We could be much more specific with the permissions, restricting them per book, but this is a good first step.

In the `books/models.py` file we'll add a `Meta` class and set both the permission name and a description which will be visible in the admin.

Code

```
# books/models.py
...
class Book(models.Model):
    id = models.UUIDField(
        primary_key=True,
        default=uuid.uuid4,
        editable=False)
    title = models.CharField(max_length=200)
    author = models.CharField(max_length=200)
    price = models.DecimalField(max_digits=6, decimal_places=2)
    cover = models.ImageField(upload_to="covers/", blank=True)

    class Meta: # new
        permissions = [
            ("special_status", "Can read all books"),
        ]

    def __str__(self):
        return self.title

    def get_absolute_url(self):
        return reverse("book_detail", args=[str(self.id)])
...
```

The order of the inner classes and methods here is deliberate. It follows the [Model style](#) section from the Django documentation.

Since we have updated our database model we must create a new migrations file and then migrate the database to apply it.

Shell

```
$ docker-compose exec web python manage.py makemigrations books
Migrations for 'books':
  books/migrations/0004_alter_book_options.py
    - Change Meta options on book
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, books, contenttypes, sessions, si\
tes
Running migrations:
  Applying books.0004_alter_book_options... OK
```

User Permissions

Now we need to apply this custom permission to our new special user. Thanks to the admin this is not a difficult task. Navigate to the Users section where the three existing users are listed: `special@email.com`, `testuser@email.com`, and your superuser account (mine has an email address of `will@wsvincent.com`).

✓ The user "special" was changed successfully.

Select user to change

ADD USER +

Q Search

Action: Go 0 of 3 selected

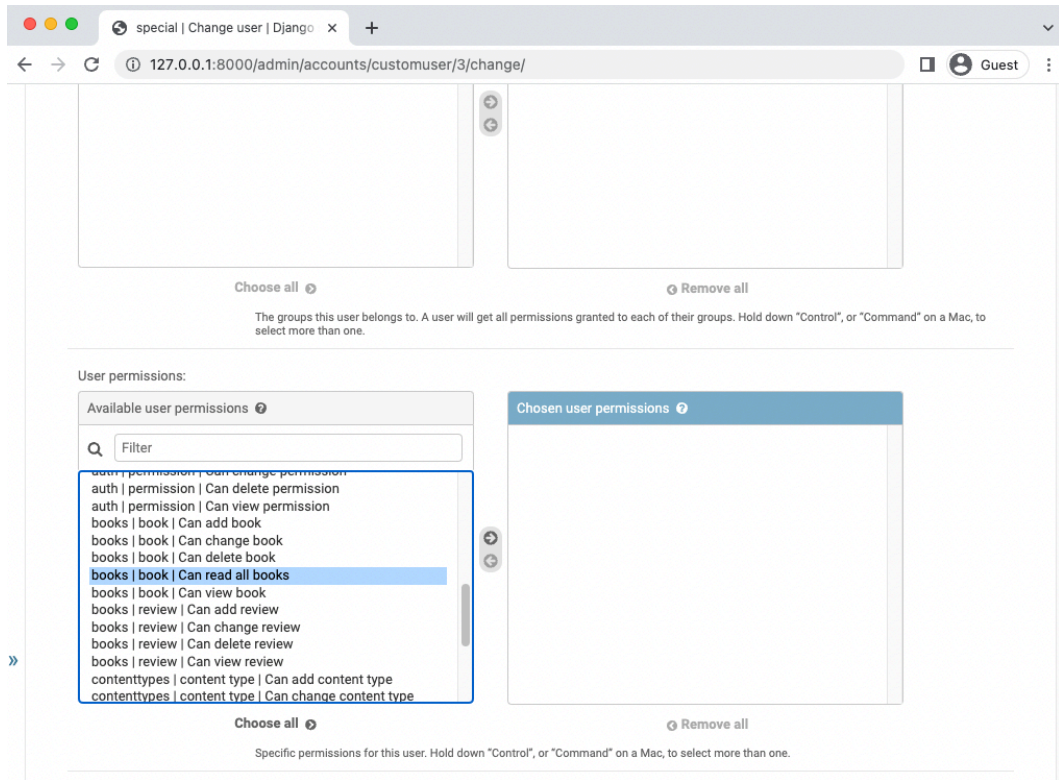
<input type="checkbox"/>	EMAIL ADDRESS	USERNAME	SUPERUSER STATUS
<input type="checkbox"/>	special@email.com	special	No
<input type="checkbox"/>	testuser@email.com	testuser	No
<input type="checkbox"/>	will@wsvincent.com	wsv	Yes

3 users

FILTER
By staff status
[All](#)
Yes
No
By superuser status
[All](#)
Yes
No
By active
[All](#)
Yes
No

Special User

Click on the special@email.com user and then scroll down to User permissions near the bottom of the page. Within it search for books | book | Can read all books and select it.



Can read all books

Click on the → arrow to add it to “Chosen user permissions.” Don’t forget to click the “Save” button at the bottom of the page.

special | Change user | Django

127.0.0.1:8000/admin/accounts/customuser/3/change/

Guest

Choose all

Remove all

The groups this user belongs to. A user will get all permissions granted to each of their groups. Hold down "Control", or "Command" on a Mac, to select more than one.

User permissions:

Available user permissions

Filter

auth | permission | Can change permission

auth | permission | Can delete permission

auth | permission | Can view permission

books | book | Can add book

books | book | Can change book

books | book | Can delete book

books | book | Can view book

books | review | Can add review

books | review | Can change review

books | review | Can delete review

books | review | Can view review

contenttypes | content type | Can add content type

contenttypes | content type | Can change content type

contenttypes | content type | Can delete content type

Choose all

Chosen user permissions

books | book | Can read all books

Remove all

Specific permissions for this user. Hold down "Control", or "Command" on a Mac, to select more than one.

Important dates

Last login:

Date:

Today

Time:

Now

Note: You are 4 hours behind server time.

Date joined:

Date:

2022-05-18

Today

Time:

14:34:19

Now

Note: You are 4 hours behind server time.

Delete

Save and add another

Save and continue editing

SAVE

Add Permission

PermissionRequiredMixin

The last step is to apply the custom permission using the [PermissionRequiredMixin](#). One of the many great features of class-based views is we can implement advanced functionality with very little code on our part and this particular mixin is a good example of that.

We will add `PermissionRequiredMixin` to our list of imports on the top line. Then add it to `DetailView` *after* `LoginRequiredMixin` but before `DetailView`. The order should make sense: if a user isn't already logged in it makes no sense to do the additional check of whether they have permission. Finally add a `permission_required` field which specifies the desired permission. In our case its name is `special_status` and it exists on the `books` model.

Code

```
# books/views.py
from django.contrib.auth.mixins import (
    LoginRequiredMixin,
    PermissionRequiredMixin # new
)
from django.views.generic import ListView, DetailView

from .models import Book

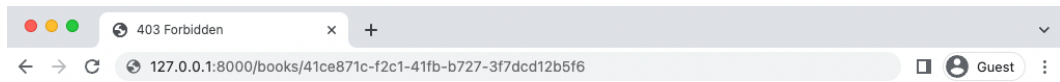
class BookListView(LoginRequiredMixin, ListView):
    model = Book
    context_object_name = "book_list"
    template_name = "books/book_list.html"
    login_url = "account_login"

class BookDetailView(
    LoginRequiredMixin,
    PermissionRequiredMixin, # new
    DetailView):
    model = Book
    context_object_name = "book"
    template_name = "books/book_detail.html"
    login_url = "account_login"
    permission_required = "books.special_status" # new
```

It is possible to add [multiple permissions](#) via the `permission_required` field, though we are not doing so here.

To try out our work, log out of the admin. This is necessary because the superuser account is used for the admin and by default has access to everything. Not a great user account to test with!

Log in to the Bookstore site using the `testuser@email.com` account and then navigate to the Books page listing the three available titles. If you then click on any one of the books, you'll see a “403 Forbidden” error because permission was denied.



403 Forbidden

403 Error Page

Now go back to the homepage at `http://127.0.0.1:8000/` and log out. Then log in using the `special@email.com` account. Navigate again to the Books page and each individual book page is accessible.

Groups & UserPassesTestMixin

The third permissions mixin available is [UserPassesTestMixin](#) which restricts a view's access only to users who pass a specific test.

And in large projects [Groups](#), which are Django's way of applying permissions to a category of users, become prominent. If you look on the Admin homepage there is a dedicated Groups section where they can be added and have permissions set. This is far more efficient than adding permissions on a per-user basis.

An example of groups is if you have a premium section on your website, a user upgrading could switch them into the premium group and then have access to however many specific extra permissions that involves.

Tests

It's a good idea to run tests whenever a code change has been made. After all, the whole point of testing is to check that we did not inadvertently cause another part of the application to fail.

Shell

```
$ docker-compose exec web python manage.py test
...
Ran 17 tests in 0.249s

FAILED (failures=2)
```

It turns out we do have some failing tests! Specifically, `test_book_list_view` and `test_book_detail_view` both complain of a 302 status code, meaning a redirection, rather than a 200 for success. This is because we've just added the requirement that log in is required to view the list of books and for a detail page the user must have a `special_status` permission.

The first step is to import `Permission` near the top of the file from the built-in auth models. Then within our `BookTests` in `books/tests.py` add the `special_status` permission to the `setUpTestData` method so it is available for all our tests.

Then we will transform the existing `test_book_list_view` test into two different tests: one for logged in users (`test_book_list_view_for_logged_in_user`) and one for logged out users (`test_book_list_view_for_logged_out_user`). Finally we will update and rename the existing `test_book_detail_view` to `test_book_detail_view_with_permissions` and have it check if a user has the correct permission.

Here is what the fully updated code looks like:

Code

```
# books/tests.py
from django.contrib.auth import get_user_model
from django.contrib.auth.models import Permission # new
from django.test import Client, TestCase
from django.urls import reverse

from .models import Book, Review

class BookTests(TestCase):

    @classmethod
    def setUpTestData(cls):
        cls.user = get_user_model().objects.create_user(
            username="reviewuser",
            email="reviewuser@email.com",
            password="testpass123"
        )

        cls.special_permission = Permission.objects.get(
            codename="special_status"
        ) # new

        cls.book = Book.objects.create(
            title="Harry Potter",
            author="JK Rowling",
            price="25.00",
        )

        cls.review = Review.objects.create(
            book = cls.book,
            author = cls.user,
            review = "An excellent review",
        )

    def test_book_listing(self):
        self.assertEqual(f"{self.book.title}", "Harry Potter")
        self.assertEqual(f"{self.book.author}", "JK Rowling")
        self.assertEqual(f"{self.book.price}", "25.00")

    def test_book_list_view_for_logged_in_user(self): # new
        self.client.login(email="reviewuser@email.com", password="testpass123")
        response = self.client.get(reverse("book_list"))
        self.assertEqual(response.status_code, 200)
        self.assertContains(response, "Harry Potter")
```

```

self.assertTemplateUsed(response, "books/book_list.html")

def test_book_list_view_for_logged_out_user(self): # new
    self.client.logout()
    response = self.client.get(reverse("book_list"))
    self.assertEqual(response.status_code, 302) # new
    self.assertRedirects(
        response, "%s?next=/books/" % (reverse("account_login")))
    response = self.client.get(
        "%s?next=/books/" % (reverse("account_login")))
    self.assertContains(response, "Log In")

def test_book_detail_view_with_permissions(self): # new
    self.client.login(email="reviewuser@email.com", password="testpass123")
    self.user.user_permissions.add(self.special_permission)
    response = self.client.get(self.book.get_absolute_url())
    no_response = self.client.get("/books/12345/")
    self.assertEqual(response.status_code, 200)
    self.assertEqual(no_response.status_code, 404)
    self.assertContains(response, "Harry Potter")
    self.assertContains(response, "An excellent review")
    self.assertTemplateUsed(response, "books/book_detail.html")

```

If you run the test suite again all tests should pass.

Shell

```
$ docker-compose exec web python manage.py test
```

```
...
```

```
Ran 18 tests in 0.384s
```

```
OK
```

Git

Make sure to create a new Git commit for the changes in this chapter.

Shell

```
$ git status  
$ git add .  
$ git commit -m 'ch14'
```

As always you can compare your code again the [official source code on Github](#).

Conclusion

Permissions and groups are a highly subjective topic that can vary widely from project to project. The basic approach, however, remains the same and mimic what we've covered here: start by restricting access and only gradually loosed it to users as needed. In our case we restricted access to only logged in users and from there added additional permissions around what groups of logged in users could view.

In the next chapter we'll add search functionality to our Bookstore site.

Chapter 15: Search

Search is a fundamental feature of most websites and certainly anything e-commerce related like our Bookstore. In this chapter we will learn how to implement basic search with forms and filters. Then we will improve it with additional logic and touch upon ways to go even more deeply with search options in Django. We only have three books in our database now but the code here will scale to as many books as we'd like.

Search functionality consists of two parts: a form to pass along a user search query and then a results page that performs a filter based on that query. Determining “the right” type of filter is where search becomes interesting and hard. But first we need to create both a form and the search results page.

We could start with either one at this point, but we'll configure the filtering first and then the form.

Search Results Page

We'll start with the search results page. As with all Django pages that means adding a dedicated URL, view, and template. The implementation order doesn't particularly matter, but we will add them in that order.

Within `books/urls.py`, add a `search/` path with a URL name of `search_results` that uses a view called `SearchResultsListView`.

Code

```
# books/urls.py
from django.urls import path

from .views import BookListView, BookDetailView, SearchResultsListView # new

urlpatterns = [
    path("", BookListView.as_view(), name="book_list"),
    path("<uuid:pk>", BookDetailView.as_view(), name="book_detail"),
    path("search/", SearchResultsListView.as_view(),
        name="search_results"), # new
]
```

Next up is the view `SearchResultsListView` which is, for now, a listing of all available books. That's a prime candidate for using `ListView`. Its template will be called `search_results.html` and live within the `templates/books/` directory. The only new code is for `SearchResultsListView` as we have previously imported both `ListView` and the `Book` model at the top of the file.

Code

```
# books/views.py
...
class SearchResultsListView(ListView): # new
    model = Book
    context_object_name = "book_list"
    template_name = "books/search_results.html"
```

Last up is creating our template, `templates/books/search_results.html`, in the text editor. For now it will list all available books by title, author, and price.

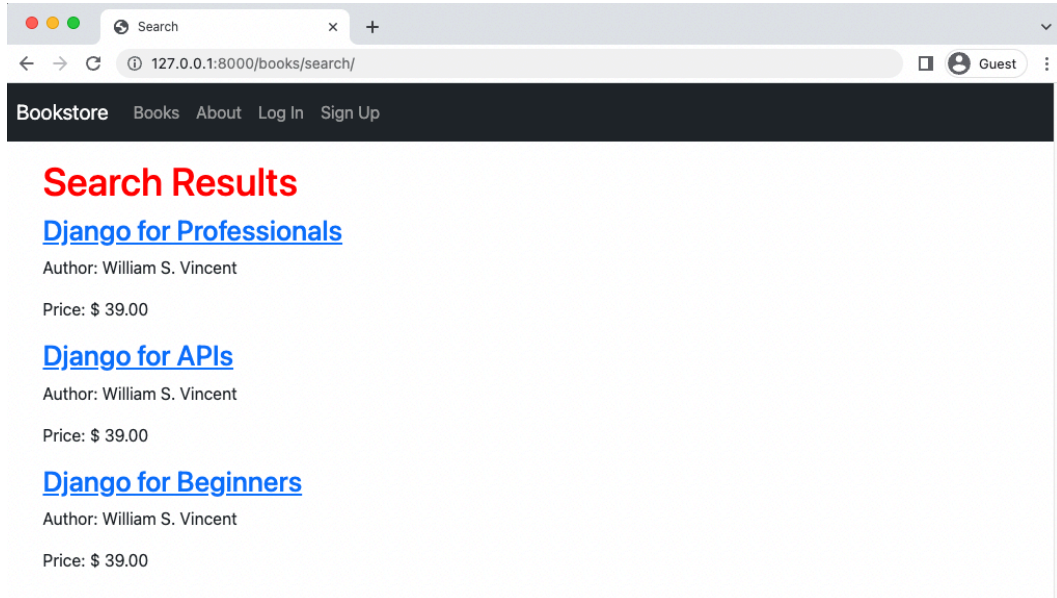
Code

```
<!-- templates/books/search_results.html -->
{% extends "_base.html" %}

{% block title %}Search{% endblock title %}

{% block content %}
<h1>Search Results</h1>
{% for book in book_list %}
<div>
    <h3><a href="{{ book.get_absolute_url }}">{{ book.title }}</a></h3>
    <p>Author: {{ book.author }}</p>
    <p>Price: $ {{ book.price }}</p>
</div>
{% endfor %}
{% endblock content %}
```

If you are still logged into a user account, log out now. The search results page is now available for all users at <http://127.0.0.1:8000/books/search/>.



Search page

And there it is!

Basic Filtering

In Django a [QuerySet](#) is used to filter the results from a database model. Currently our search results page doesn't feel like one because it is outputting *all* results from the `Book` model. Ultimately we want to run the filter based on the user's search query, but first we'll work through multiple filtering options.

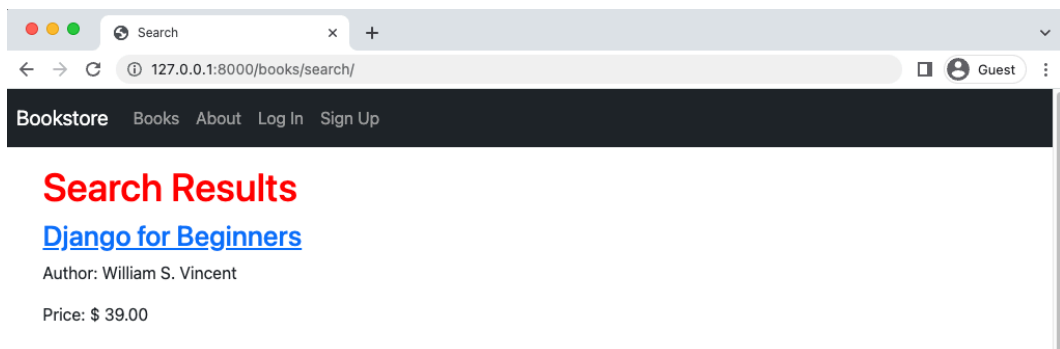
It turns out there are multiple ways to customize a queryset including via a [manager](#) on the model itself but to keep things simple, we can add a filter with just one line. So let's do that!

We can override the default `queryset` attribute on `ListView` which by default shows all results. The queryset documentation is quite robust and detailed, but often using [contains](#) (which is case sensitive) or [icontains](#) (which is not case sensitive) are good starting points. We will implement the filter based on the `title` that “contains” the name “beginners”.

Code

```
# books/views.py
class SearchResultsListView(ListView):
    model = Book
    context_object_name = "book_list"
    template_name = "books/search_results.html"
    queryset = Book.objects.filter(title__icontains="beginners") # new
```

Refresh the search results page and now only a book with the title containing “beginners” is displayed. Success!



Search page for “beginners”

For basic filtering most of the time the [built-in queryset methods](#) of `filter()`, `all()`, `get()`, or `exclude()` will be enough. However there is also a very robust and detailed [QuerySet API](#) available as well that is worthy of further study.

Q Objects

Using `filter()` is powerful and it's even possible to [chain filters](#) together such as search for all titles that contain “beginners” and “django”. However often you’ll want more complex lookups that can use “OR” not just “AND”; that’s when it is time to turn to [Q objects](#).

Here’s an example where we set the filter to look for a result that matches a title of either “beginners” or “api”. It’s as simple as importing `Q` at the top of the file and then subtly tweaking our existing query. The `|` symbol represents the “or” operator. We can filter on any available field: not just `title` but also `author` or `price` as desired.

As the number of filters grows it can be helpful to separate out the queryset override via `get_queryset()`. That’s what we’ll do here but note that this choice is optional.

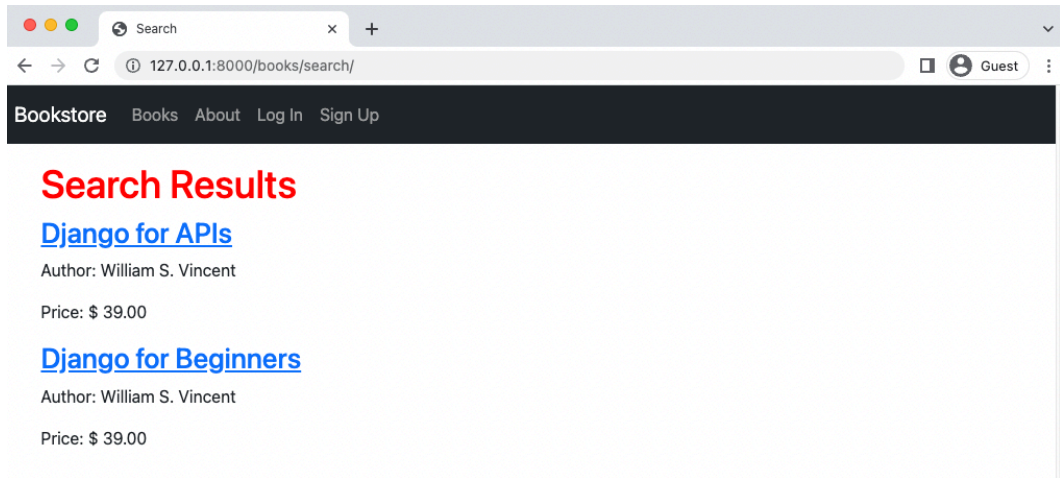
Code

```
# books/views.py
from django.db.models import Q # new
...

class SearchResultsListView(ListView):
    model = Book
    context_object_name = "book_list"
    template_name = "books/book_list.html"

    def get_queryset(self): # new
        return Book.objects.filter(
            Q(title__icontains="beginners") | Q(title__icontains="api")
        )
```

Refresh the search results page to see the new result.



Search with Q objects

Now let's turn our attention to the corresponding search form so that rather than hardcode our filters in we can populate them based on the user's search query.

Forms

Fundamentally a web form is simple: it takes user input and sends it to a URL via either a GET or POST method. However in practice this fundamental behavior of the web can be monstrously complex.

The first issue is sending the form data: where does the data actually go and how do we handle it once there? Not to mention there are numerous security concerns whenever we allow users to submit data to a website.

There are only two options for “how” a form is sent: either via GET or POST HTTP methods.

A POST bundles up form data, encodes it for transmission, sends it to the server, and then receives a response. Any request that changes the state of the database—creates, edits, or deletes data—should use a POST.

A GET bundles form data into a string that is added to the destination URL. GET should only be used for requests that do not affect the state of the application, such as a search where nothing within the database is changing, basically we're just doing a filtered list view.

If you look at the URL after visiting Google.com you'll see your search query in the actual search results page URL itself.

For more information, Mozilla has detailed guides on both [sending form data](#) and [form data validation](#) that are worth reviewing if you're not already familiar with form basics.

Search Form

Let's add a basic search form to the navbar right now so it is available on every page. That means updating the `_base.html` template and in particular, the bottom of the `` tags after the `if/else/elif` logic.

Here is what the updated code looks like which we'll explain below.

Code

```
<!-- templates/_base.html -->
...
    {% endif %}
</ul>
<form class="d-flex" action="{% url 'search_results' %}" method="get">
    <input class="form-control me-2" type="search" name="q" placeholder="Search" aria-
label="Search" >
    <button class="btn btn-outline-success" type="submit">Search</button>
</form>
</div>
</div>
</nav>
```

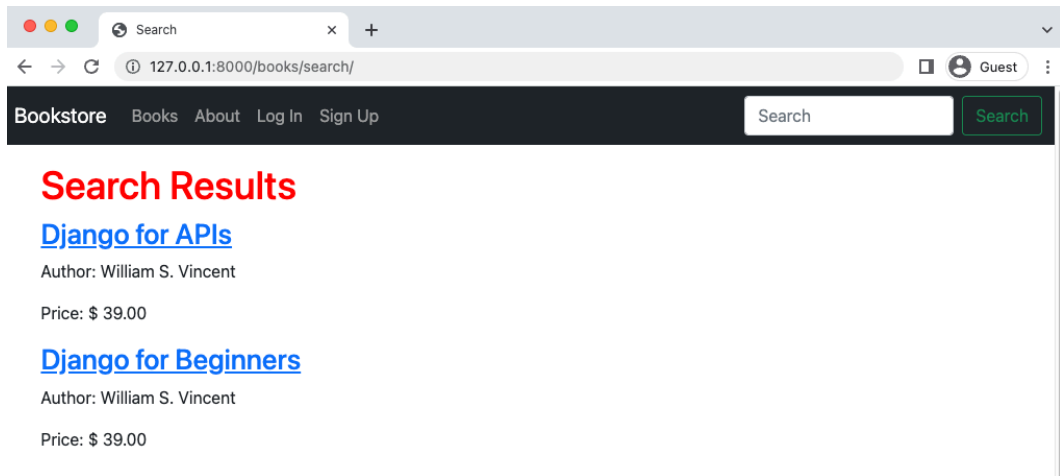
We are adding HTML `<form>` tags and using Bootstrap's styling to make them look nice. The `action` specifies where to redirect the user after the form is submitted, which will be the URL named `search_results` page. As with all URL links this is the URL name for the page. Then we indicate the desired method of `get` rather than `post`.

The second part of the form is the `input` which contains the user search query. We provide it with a variable name, `q`, which will be later visible in the URL and also available in the views file. We add Bootstrap styling with the `class`, specify the `type` of input is text, add a `placeholder` which is default text that prompts the user. The last part, `aria-label`, is the name provided to screen

reader users. Accessibility is a big part of web development and should always be considered from the beginning: include `aria-labels` with all your forms!

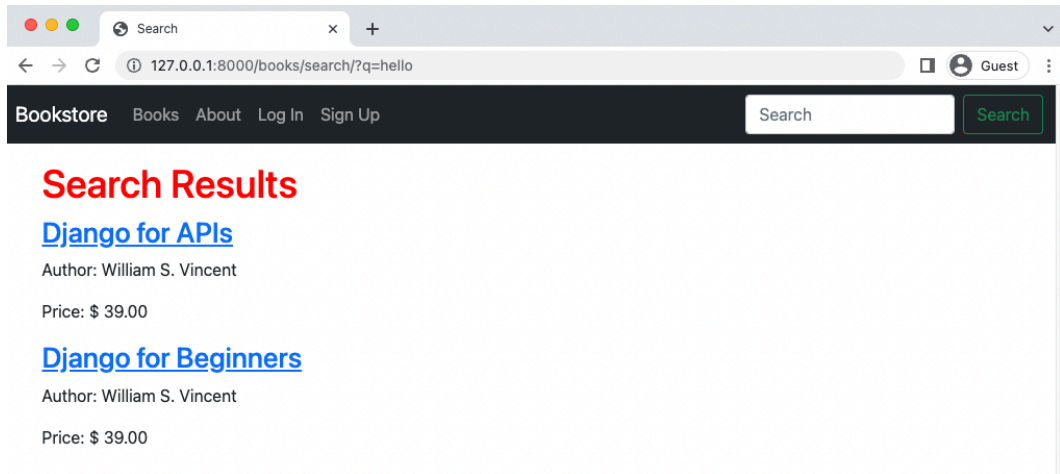
Finally we're including a "Search" button to be clicked on to run the search query. A user can also just press Return to achieve the same result.

Navigate to the homepage—or any page really—and the new search box is present in the upper right.



Homepage with search box

Try inputting a search, for example for "hello." Upon hitting Return or clicking the "Search" button you are redirected to the search results page. Note, in particular, the URL contains the search query `/search/?q=hello`.



URL with query string

However the results haven't changed! And that's because our `SearchResultsListView` still has the hardcoded values from before. The last step is to take the user's search query, represented by `q` in the URL, and pass it in to the actual search filters.

Code

```
# books/views.py
class SearchResultsListView(ListView):
    model = Book
    context_object_name = "book_list"
    template_name = "books/search_results.html"

    def get_queryset(self): # new
        query = self.request.GET.get("q")
        return Book.objects.filter(
            Q(title__icontains=query) | Q(author__icontains=query)
        )
```

What changed? We added a `query` variable that takes the value of `q` from the form submission. Then updated our filter to use `query` on either a `title` or an `author` field. That's it! Refresh the search results page—it still has the same URL with our query—and the result is expected: no results on either `title` or `author` for “hello”.

Go back to the homepage and try a new search such as for “api” or “beginners” to see the complete search functionality in action.

Git

Make sure to save our current work in this chapter by committing the new code to Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch15'
```

The official source code for this chapter is [available on Github](#).

Conclusion

Our basic search is now complete, but we've only scratched the surface of potential search optimizations. For example, maybe we want a button added to the search form that could be clicked in addition to hitting the Return key? Or better yet include form validation. Beyond filtering with ANDs and ORs there are other factors if we want a Google-quality search, things like relevancy and much more.

There are several third-party packages with enhanced features such as [django-watson](#) or [django-haystack](#) however, given that we're using PostgreSQL as the database, we can take advantage of its [full text search](#) and other features which are built into Django itself.

A final option is either use an enterprise-level solution like [ElasticSearch](#) that must be running on a separate server (not the hardest thing with Docker), or rely on a hosted solution like [Swifttype](#) or [Algolia](#).

In the next chapter we'll explore the many performance optimizations available in Django as we prepare our Bookstore project for eventual deployment.

Chapter 16: Performance

The first priority for any website is that it must work properly and contain proper tests. But if your project is fortunate enough to receive a large amount of traffic the focus quickly shifts to performance and making things as efficient as possible. This is a fun and challenging exercise for many engineers, but it can also be a trap.

The computer scientist Donald Knuth has [a famous quote](#) worth reading in its entirety:

“The real problem is that programmers have spent far too much time worrying about efficiency in the wrong places and at the wrong times; premature optimization is the root of all evil (or at least most of it) in programming.”

While it’s important to set up proper monitoring so you *can* optimize your project later on, don’t focus too much on it upfront. There’s no way to properly mimic production environments locally. And there is no way to predict exactly how a site’s traffic will look. But it is possible to spend far too much time seeking out tiny performance gains in the early stages instead of talking to users and making larger code improvements!

In this chapter we’ll focus on the broad strokes of Django-related performance and highlight areas worth further investigation at scale. Generally speaking performance comes down to four major areas: optimizing database queries, caching, indexes, and compressing front-end assets like images, JavaScript, and CSS.

django-debug-toolbar

Before we can optimize our database queries we need to see them. The go-to tool for this in the Django community is the third-party package [django-debug-toolbar](#). It comes with a configurable set of panels to inspect the complete request/response cycle of any given page.

Per usual we can install it by adding the latest version to our `requirements.txt` file.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycpg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
environs[django]==9.5.0
pillow==9.0.1
django-debug-toolbar==3.4.0
```

Then stop our container, rebuild the image, and run the container again.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

There are three separate configurations to set in our `django_project/settings.py` file:

1. `INSTALLED_APPS`
2. `Middleware`
3. `INTERNAL_IPS`

First add Debug Toolbar to the `INSTALLED_APPS` configuration. Note that the proper name is `debug_toolbar` not `django_debug_toolbar` as might be expected.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    "django.contrib.sites",
    # Third-party
    "crispy_forms",
    "crispy_bootstrap5",
    "allauth",
    "allauth.account",
    "debug_toolbar", # new
    # Local
    "accounts.apps.AccountsConfig",
    "pages.apps.PagesConfig",
    "books.apps.BooksConfig",
]
```

Second, add Debug Toolbar to the Middleware where it is primarily implemented.

Code

```
# django_project/settings.py
MIDDLEWARE = [
    "django.middleware.security.SecurityMiddleware",
    "django.contrib.sessions.middleware.SessionMiddleware",
    "django.middleware.common.CommonMiddleware",
    "django.middleware.csrf.CsrfViewMiddleware",
    "django.contrib.auth.middleware.AuthenticationMiddleware",
    "django.contrib.messages.middleware.MessageMiddleware",
    "django.middleware.clickjacking.XFrameOptionsMiddleware",
    "debug_toolbar.middleware.DebugToolbarMiddleware", # new
]
```

And third, set the `INTERNAL_IPS` as well. If we were not in Docker this could be set to `'127.0.0.1'`, however, since we're running our web server within Docker an additional step is required so that it matches the machine address of Docker. Add the following lines at the bottom of `config/settings.py`.

Code

```
# django_project/settings.py
...
# django-debug-toolbar
import socket

hostname, _, ips = socket.gethostbyname_ex(socket.gethostname())
INTERNAL_IPS = [ip[:-1] + "1" for ip in ips]
```

Phew. That looks a bit scary, but basically it ensures that our `INTERNAL_IPS` matches that of our Docker host.

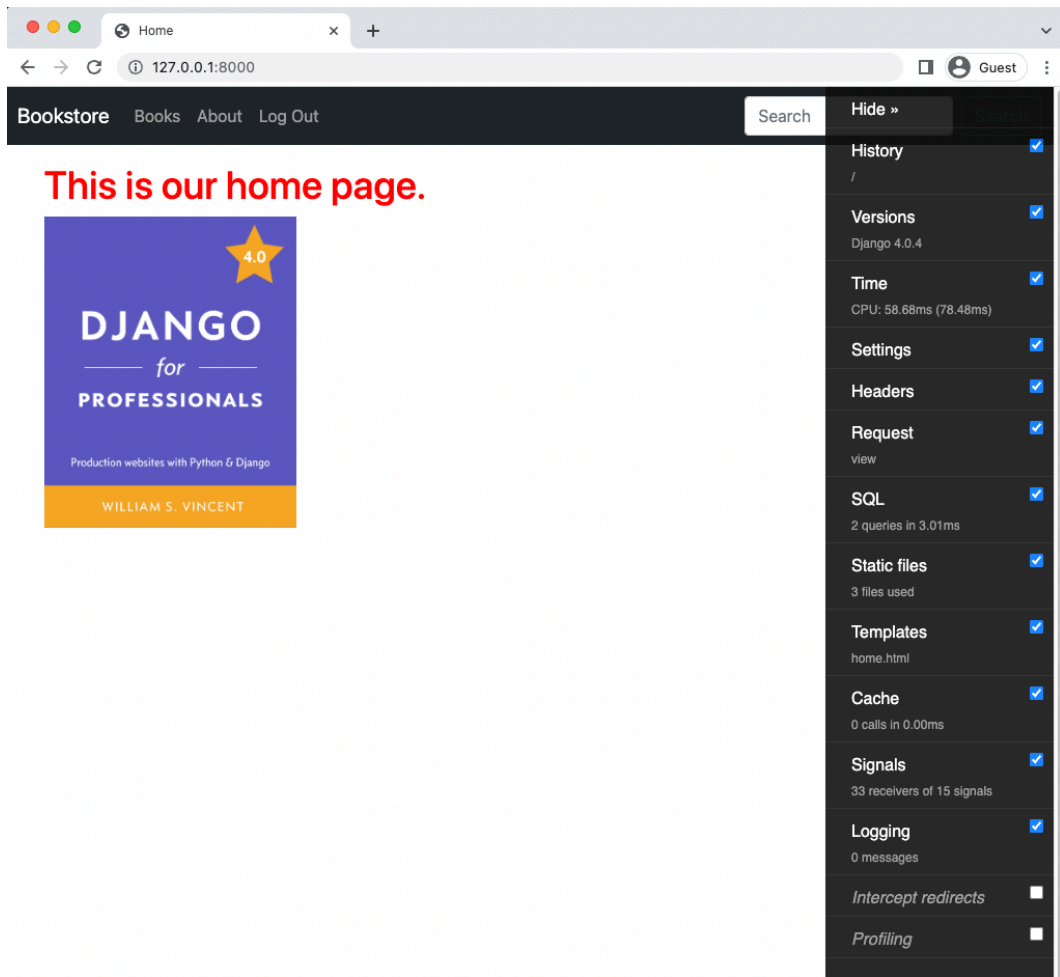
There's one last step and that is to update our `URLconf`. We only want Debug Toolbar to appear if `DEBUG` is true so we'll add logic to display it only in this case at the bottom of the `django_project/urls.py` file.

Code

```
# django_project/urls.py
...
if settings.DEBUG: # new
    import debug_toolbar

    urlpatterns = [
        path("__debug__/", include(debug_toolbar.urls)),
    ] + urlpatterns
```

Now if you refresh the homepage you'll see the `django-debug-toolbar` on the righthand side.



Debug Toolbar

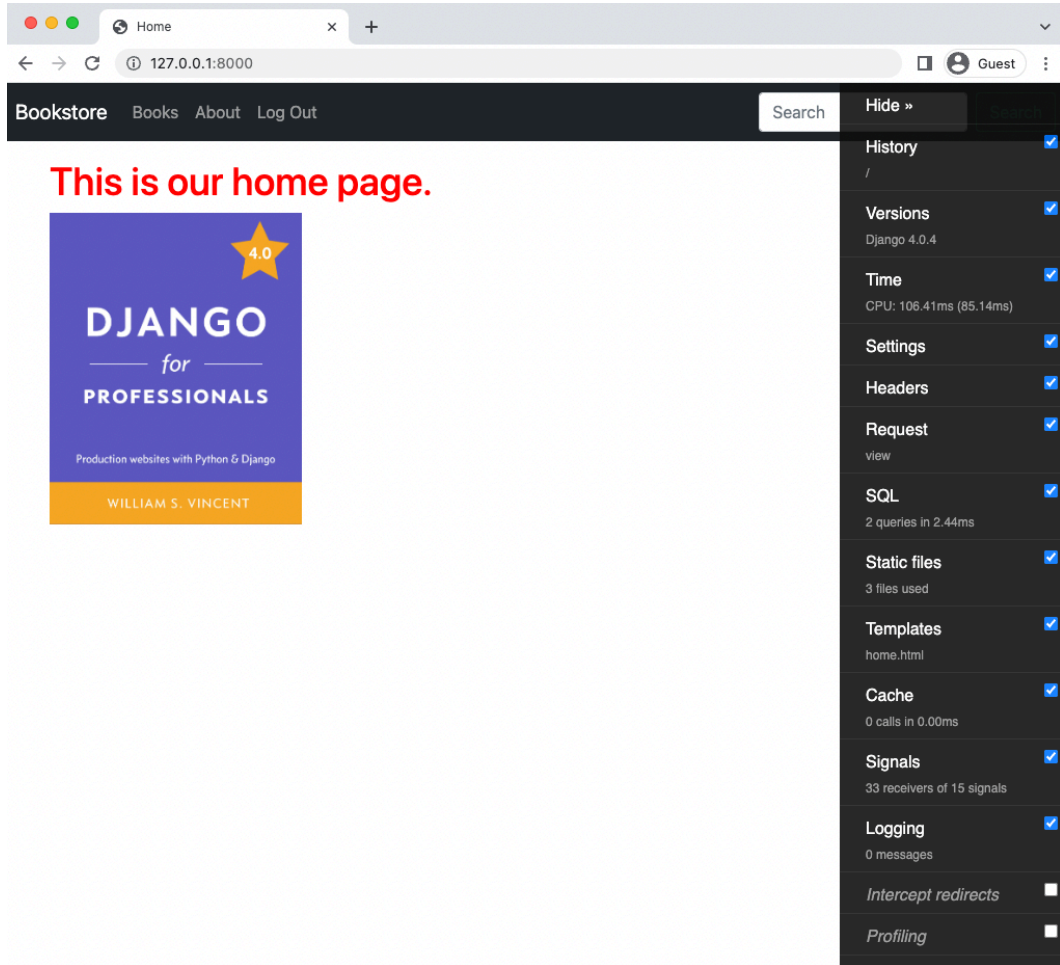
If you click the “Hide” link on top it becomes a much smaller sidebar on the righthand side of the page.

Analyzing Pages

Debug Toolbar has [many possible customizations](#) but the default settings visible tell us a lot about our homepage. For instance, we can see the current version of Django being used as well

as the Time it took to load the page.

Probably the most useful item, however, is SQL which shows the queries on a specific page. If you are logged out right now, there are no SQL queries on the homepage. So go ahead and log in with your superuser account and then return the homepage. Debug Toolbar shows that two queries are being run for logged in users.



Debug Toolbar

Over on the Django for Professionals book page there are six queries being run:

- the [sessions framework](#) to manage users

- to accounts_customuser to load our user
- to books_book to load the “Django for Professionals” book
- to books_review to load the reviews
- and then 2 more queries to accounts_customuser

SQL queries from 1 connection

default 8.13 ms (6 queries including 3 similar and 2 duplicates)

Query	Timeline	Time (ms)	Action
SELECT ... FROM "django_session" WHERE ("django_session"."expire_date" > '2022-05-18T16:02:47.557256+00:00':timestampz AND "django_session"."session_key" = 'g2dz1a8zh1feslvago2k9d3gt6yhpjbq') LIMIT 21		6.03	Sel Expl
SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 1 LIMIT 21 3 similar queries.		0.47	Sel Expl
SELECT ... FROM "books_book" WHERE "books_book"."id" = 'e449e8c9-47c7-47ca-b310-f36dc988f6e4':uuid LIMIT 21		0.36	Sel Expl
SELECT ... FROM "books_review" WHERE "books_review"."book_id" = 'e449e8c9-47c7-47ca-b310-f36dc988f6e4':uuid		0.89	Sel Expl
SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21 3 similar queries. Duplicated 2 times.		0.18	Sel Expl
SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21 3 similar queries. Duplicated 2 times.		0.21	Sel Expl

Hide »

- History** ☒
 - /books/e449e8c9-47c7-47ca-b310-f36dc988f6e4
- Versions** ☒
 - Django 4.0.4
- Time** ☒
 - CPU: 42.20ms (60.93ms)
- Settings** ☒
- Headers** ☒
- Request** ☒
 - view
- SQL** ☒
 - 6 queries in 8.13ms
- Static files** ☒
 - 2 files used
- Templates** ☒
 - books/book_detail.html
- Cache** ☒
 - 0 calls in 0.00ms
- Signals** ☒
 - 35 receivers of 15 signals
- Logging** ☒
 - 0 messages
- Intercept redirects** ☐
- Profiling** ☐

Debug Toolbar SQL Queries

Six queries doesn't seem too bad. But what if we had a lot of reviews for a book? Go into the admin and to the entry for the “Django for Professionals” book. Add eight more reviews—all by testuser—so there are now ten total and click “Save.”

Django for Professionals | Change
+

127.0.0.1:8000/admin/books/book/e449e8c9-47c7-47ca-b310-f36dc988f6e4/change/
Guest

Django administration
WELCOME, wsv VIEW SITE / CHANGE PASSWORD / LOG OUT

Home Books Books Django for Professionals

Change book
HISTORY VIEW ON SITE

Django for Professionals

Title:

Author:

Price:

Cover: Currently: covers/dfp_MYQv1k.jpg ☐ Clear

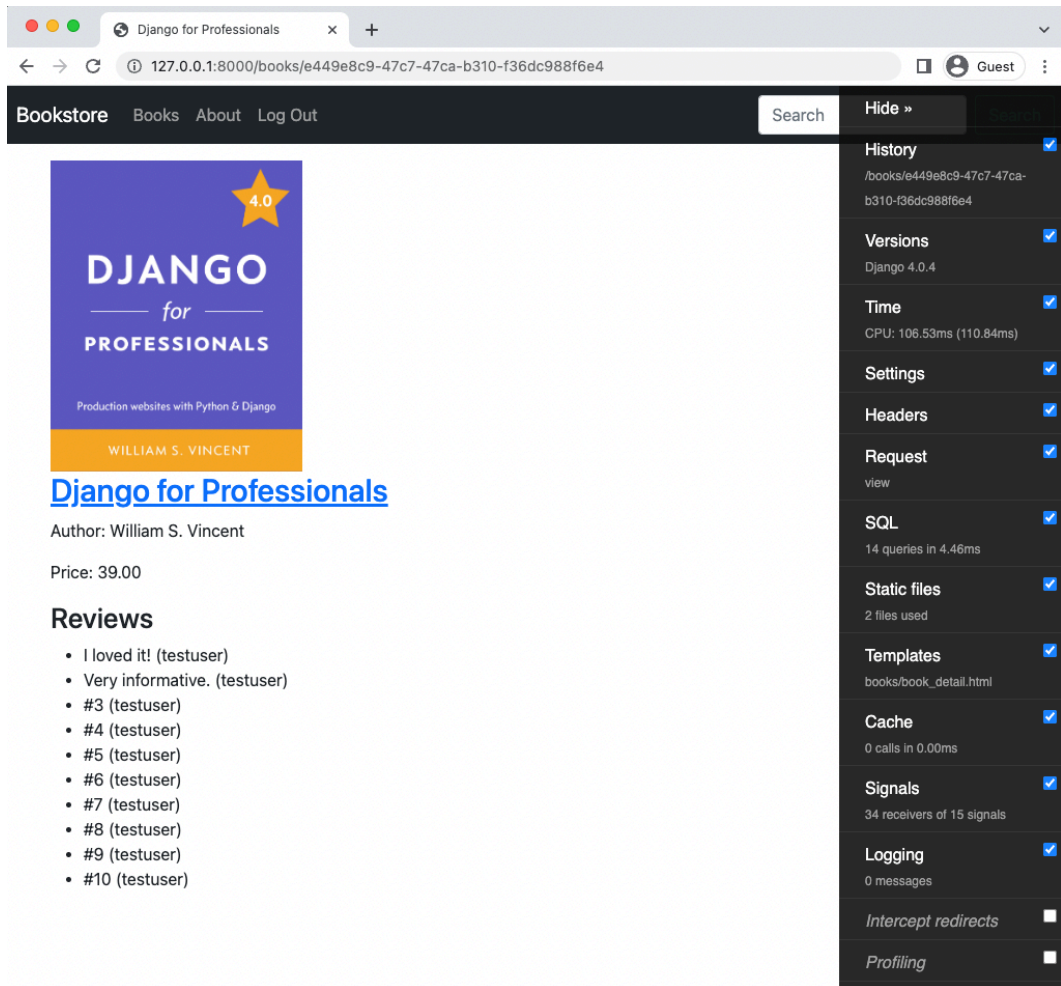
Change: No file chosen

REVIEW	AUTHOR	DELETE?
<input type="text" value="I loved it!"/>	testuser	<input type="checkbox"/>
<input type="text" value="Very informative."/>	testuser	<input type="checkbox"/>
<input type="text" value="#3"/>	testuser	
<input type="text" value="#4"/>	testuser	
<input type="text" value="#5"/>	testuser	
<input type="text" value="#6"/>	testuser	
<input type="text" value="#7"/>	testuser	
<input type="text" value="#8"/>	testuser	
<input type="text" value="#9"/>	testuser	
<input type="text" value="#10"/>	testuser	

Add another Review

Admin Ten Reviews

How many SQL queries do you think will now be on our detail page for this book? Let's head over and check!



The screenshot shows a web browser window with the URL `127.0.0.1:8000/books/e449e8c9-47c7-47ca-b310-f36dc988f6e4`. The page displays the book "Django for Professionals" by William S. Vincent, version 4.0. The price is 39.00. There are ten reviews listed, all from a user named "testuser".

The right-hand sidebar shows the following performance metrics:

- History**: ☒ `/books/e449e8c9-47c7-47ca-b310-f36dc988f6e4`
- Versions**: ☒ Django 4.0.4
- Time**: ☒ CPU: 106.53ms (110.84ms)
- Settings**: ☒
- Headers**: ☒
- Request**: ☒ view
- SQL**: ☒ 14 queries in 4.46ms
- Static files**: ☒ 2 files used
- Templates**: ☒ `books/book_detail.html`
- Cache**: ☒ 0 calls in 0.00ms
- Signals**: ☒ 34 receivers of 15 signals
- Logging**: ☒ 0 messages
- Intercept redirects**: ☐
- Profiling**: ☐

Books Page Ten Reviews

As perhaps expected there are now eight more queries to coincide with the eight new reviews meaning 14 total queries for this one page.

If you look at the SQL detail view in Django Debug Toolbar it is actually quite helpful in flagging duplicate queries. Is it really necessary to call `accounts_customuser` eleven times? There's like a way to reduce the number of queries since, after all, the books query manages to import three

books with just one query.

SQL queries from 1 connection

default 6.48 ms (14 queries including 11 similar and 10 duplicates)

Query	Timeline	Time (ms)	Action
<code>SELECT ... FROM "django_session" WHERE ("django_session"."expire_date" > "2022-05-18T16:12:49.137439+00:00":timestampz AND "django_session"."session_key" = 'g2dz1a8zh1feslvaqo2k9d3gt6yhpjbpq') LIMIT 21</code>		2.46	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 1 LIMIT 21</code> 11 similar queries.		0.98	Sel Expl
<code>SELECT ... FROM "books_book" WHERE "books_book"."id" = 'e449e8c9-47c7-47ca-b310-f36dc988f6e4':uuid LIMIT 21</code>		0.55	Sel Expl
<code>SELECT ... FROM "books_review" WHERE "books_review"."book_id" = 'e449e8c9-47c7-47ca-b310-f36dc988f6e4':uuid</code>		0.74	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.28	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.20	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.20	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.17	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.16	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.16	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.15	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.15	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.14	Sel Expl
<code>SELECT ... FROM "accounts_customuser" WHERE "accounts_customuser"."id" = 2 LIMIT 21</code> 11 similar queries. Duplicated 10 times.		0.14	Sel Expl

Hide »

History ☒

/books/e449e8c9-47c7-47ca-b310-f36dc988f6e4

Versions ☒

Django 4.0.4

Time ☒

CPU: 72.60ms (97.21ms)

Settings ☒

Headers ☒

Request ☒

view

SQL ☒

14 queries in 6.48ms

Static files ☒

2 files used

Templates ☒

books/book_detail.html

Cache ☒

0 calls in 0.00ms

Signals ☒

35 receivers of 15 signals

Logging ☒

0 messages

Intercept redirects ☐

Profiling ☐

11 Similar Queries

What we are experiencing now is a very common issue known generally as the “N+1 Queries problem.” There are several third-party packages that can help identify the issue. Fortunately there are tools to help.

select_related and prefetch_related

Reducing SQL queries is one of the first steps when optimizing a Django project. There are two powerful methods included in the Django ORM to help us that can boost performance by creating a single more complex QuerySet rather than multiple, smaller queries:

- `select_related` for Foreign Key relationships
- `prefetch_related()` for `Many to Many` relationships

`select_related` returns a QuerySet that “follows” foreign-key relationships—either One-to-One or One-to-Many—selecting additional related-object data as needed. Under the hood the Django ORM creates a SQL join and includes the fields of a related object in the `SELECT` statement, which results in all related objects being included in a single more complex database query.

`prefetch_related` performs a separate lookup for each relationship and “joins” them together with Python, not SQL. This allows it to prefetch many-to-many and many-to-one objects, which cannot be done using `select_related`.

At first glance it might seem the issue here is a Foreign Key one and calls for `select_related`. But in fact it is a Many-to-Many issue of authors to reviews since for one article there can be many reviews by many authors.

Studying your QuerySets deeply is vital for intermediate-to-advanced Django developers. There are many [built-in methods available](#) and understanding how QuerySets are built, the fact [they are unique](#) and [also lazy](#), can yield insight into speeding up performance.

We can access the [Python shell](#) directly from the command line to play around with our current QuerySets. After starting the shell the first step is to import the `Book` model from our `books` app. Then we can select all of it to see our three books.

Shell

```
$ docker-compose exec web python manage.py shell
>>> from books.models import Book
>>> Book.objects.all()
<QuerySet [<Book: Django for APIs>, <Book: Django for Beginners>, <Book: Django for Professionals>]>
```

We want to look at just the “Professionals” book now. If we were relying on the default ids for each Book, we could simply use the `get()` method but since we are using UUIDs we will instead use the `contains()` method and store the result as a variable called `pros`. Finally we can look at the all the reviews stored on it.

Shell

```
>>> pros = Book.objects.get(title__contains="Professionals")
>>> pros
<Book: Django for Professionals>
>>> pros.reviews.all()
<QuerySet [<Review: 1>, <Review: 2>, <Review: 3>, <Review: 4>, <Review: 5>, <Review: 6>, \
<Review: 7>, <Review: 8>, <Review: 9>, <Review: 10>]>
```

A very useful third-party package is [django-extensions](#) which comes with a number of Django command extensions. Among them is `shell_plus`, which automatically loads all app models in the shell. This can save a lot of time over the life of a Django project and makes working with the Django ORM much easier. But for now, we can exit the Django shell by typing `Ctrl + d`.

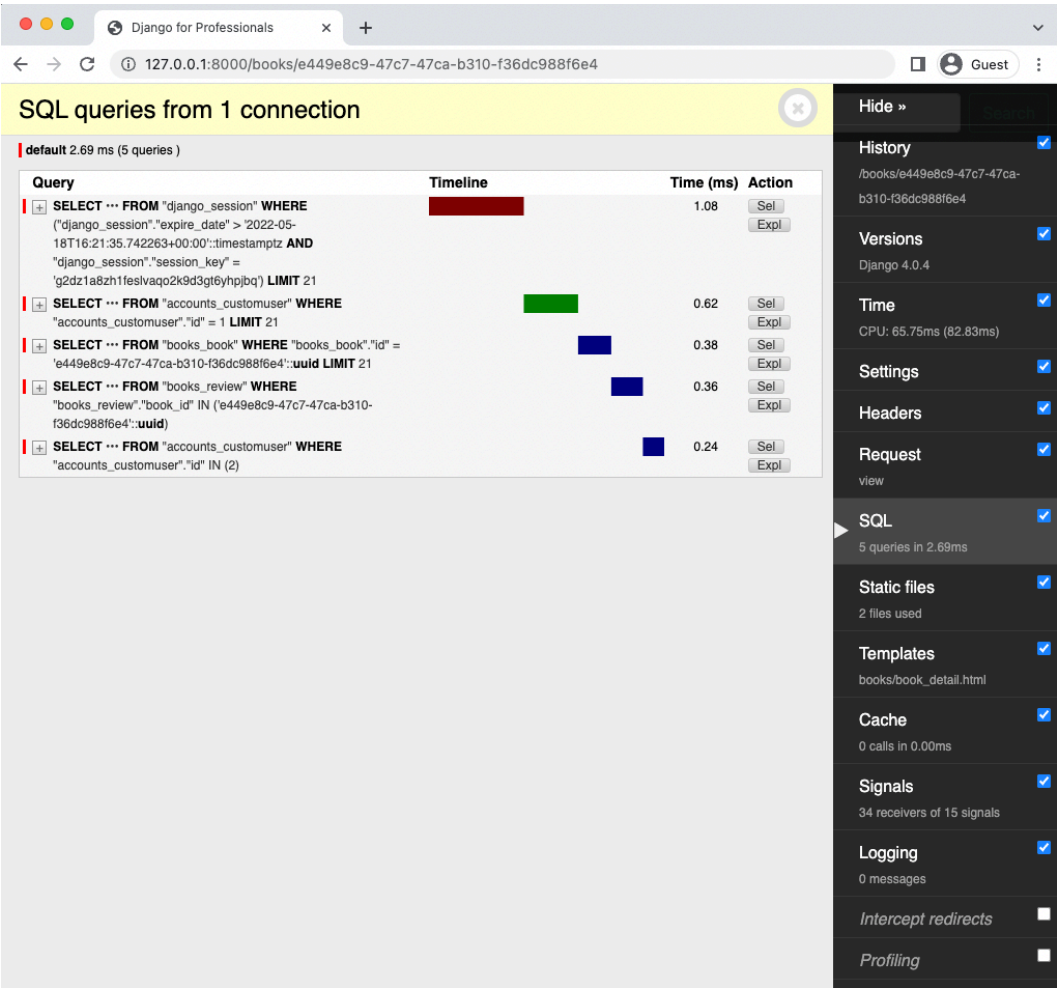
By default a `DetailView` will [return a queryset](#) that calls the `all()` method. In other words, `Book.objects.all()`. We want to update this to `prefetch_related` all the reviews for each author in one go. Here is how the update looks in our `books/views.py` file.

Code

```
# books/views.py
...
class BookDetailView(
    LoginRequiredMixin, PermissionRequiredMixin, DetailView
):
    model = Book
    context_object_name = "book"
    template_name = "books/book_detail.html"
    login_url = "account_login"
    permission_required = "books.special_status"
    queryset = Book.objects.all().prefetch_related('reviews__author',) # new
```

The double underscore here is a [lookup](#) which is commonly used to filter QuerySets.

If we refresh the web page for the “Professionals” book now `django-debug-toolbar` shows that we’ve reduced our SQL queries from 14 to 5! Which makes sense since instead of 10 different queries for each review and author we now do it once (assuming all the reviews are by the same author).



Five Queries

Indexes

Indexing is a common technique for speeding up database performance. It is a separate data structure that allows faster searches and is typically only applied to the primary key in a model. The downside is that indexes require additional space on a disk so they must be used with care. Tempting as it is to simply add indexes to primary keys from the beginning, it is better to start

without them and only add them later based on production needs. A general rule of thumb is that if a given field is being used frequently, such as 10-25% of all queries, it is a prime candidate to be indexed.

Historically an index field could be created by adding `db_index=True` to any model field. For example, if we wanted to add one to the `id` field in our `Book` model it would look as follows (don't actually implement this though).

Code

```
# books/models.py
...
class Book(models.Model):
    id = models.UUIDField(
        primary_key=True,
        db_index=True, # new
        default=uuid.uuid4,
        editable=False)
...
```

This change would need to be added via a migration file and migrated.

Starting in [Django 1.11](#), class-based model indexes were added so can include in the [Meta section](#) instead. So you could write the previous index as follows instead:

Code

```
# books/models.py
...
class Book(models.Model):
    id = models.UUIDField(
        primary_key=True,
        default=uuid.uuid4,
        editable=False)
...

class Meta:
    indexes = [ # new
        models.Index(fields=["id"], name="id_index"),
    ]
    permissions = [
        ("special_status", "Can read all books"),
    ]
```

Since we've changed the model we must create a migrations file and apply it.

Shell

```
$ docker-compose exec web python manage.py makemigrations books
Migrations for 'books':
  books/migrations/0005_book_id_index.py
    - Create index id_index on field(s) id of model book
$ docker-compose exec web python manage.py migrate
Operations to perform:
  Apply all migrations: account, accounts, admin, auth, books, contenttypes, sessions, si\
tes
Running migrations:
  Applying books.0005_book_id_index... OK
```

Caching

A cache is an in-memory storing of an expensive calculation. Once executed it doesn't need to be run again!

Consider that our Bookstore project is a dynamic website. Each time a user requests a page our server has to make various calculations including database queries, template rendering, and so on before servicing it. This takes time and is much slower than simply reading a file from a static site where the content does not change.

On large sites, though, this type of overhead can be quite slow and caching is one of the first solutions in a web developer's tool bag. Implementing caching on our current project is definitely overkill, but we will nonetheless review the options and implement a basic version.

Django has its own [cache framework](#) which includes four different caching options in descending order of granularity:

- 1) The [per-site cache](#) is the simplest to set up and caches your entire site.
- 2) The [per-view cache](#) lets you cache individual views.
- 3) [Template fragment caching](#) lets you specify a specific section of a template to cache.
- 4) The [low-level cache API](#) lets you manually set, retrieve, and maintain specific objects in the cache.

Why not just cache everything all the time? Two big reasons. The first is that cache memory is expensive since it is stored as RAM. Think about the cost of going from 8GB to 16GB of RAM on your laptop vs. 256GB to 512GB of hard drive space! Another is the cache must be “warm,” that is filled with updated content, so depending upon the needs of a site, optimizing the cache so it is accurate, but not wasteful, takes quite a bit of tuning.

If you wanted to implement per-site caching, which is the simplest approach, you’d add `UpdateCacheMiddleware` at the very top of the `MIDDLEWARE` configuration in `django_project/settings.py` and `FetchFromCacheMiddleware` at the very bottom. Also set three additional fields `CACHE_MIDDLEWARE_ALIAS`, `CACHE_MIDDLEWARE_SECONDS`, and `CACHE_MIDDLEWARE_KEY_PREFIX`.

Code

```
# django_project/settings.py
MIDDLEWARE = [
    "django.middleware.cache.UpdateCacheMiddleware", # new
    "django.middleware.security.SecurityMiddleware",
    "django.contrib.sessions.middleware.SessionMiddleware",
    "django.middleware.common.CommonMiddleware",
    "debug_toolbar.middleware.DebugToolbarMiddleware",
    "django.middleware.csrf.CsrfViewMiddleware",
    "django.contrib.auth.middleware.AuthenticationMiddleware",
    "django.contrib.messages.middleware.MessageMiddleware",
    "django.middleware.clickjacking.XFrameOptionsMiddleware",
    "debug_toolbar.middleware.DebugToolbarMiddleware",
    "django.middleware.cache.FetchFromCacheMiddleware", # new
]

CACHE_MIDDLEWARE_ALIAS = "default"
CACHE_MIDDLEWARE_SECONDS = 604800
CACHE_MIDDLEWARE_KEY_PREFIX = ""
```

The only default you might want to adjust is `CACHE_MIDDLEWARE_SECONDS` which is the default number of seconds (600) to cache a page. After the period is up, the cache expires and becomes empty. A good default when starting out is 604800 seconds or 1 week (60secs x 60minutes x 168hours) for a site with content that doesn’t change very often. But if you find your cache filling up rapidly or you are running a site where the content changes on a frequent basis, shortening this setting is a good first step.

Implementing caching is strictly optional at this point though. Once a website is up and running the need for caching—per site, per page, and so on—will quickly become apparent. As a site grows in size, a dedicated and separate caching server often makes sense. The two most popular options for this are [Redis](#) and [Memcached](#) which, as of Django 4.0, both come with built-in Django support.

Front-end Assets

Another major source of bottlenecks in a website is loading front-end assets. CSS and JavaScript can become quite large and therefore tools like [django-compressor](#) can help to minimize their size.

Images are often the first place to look in terms of asset size. The static/media file set up we have in place will scale to a quite large size, but for truly large sites it is worth investigating the use of a [Content Delivery Network \(CDN\)](#) for images instead of storing them on the server filesystem.

You can also serve different size images to users. For example, rather than shrink down a large book cover for a list or search page you could store a smaller thumbnail version instead and serve *that* where needed. The third-party [easy-thumbnails](#) package is a good place to start for this.

A fantastic free e-book on the topic is [Essential Image Optimization](#) by Addy Osmani that goes into depth on image optimization and automations.

As a final check there are automated tests for front-end speed such as Google's [PageSpeed Insights](#) that will assign a score based on how quickly a page loads.

Next Steps

Git

There's been a lot of code changes in this chapter so make sure to commit everything with Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch16'
```

If you have any errors make sure to look at your logs with `docker-compose logs` and compare your code with the [official source code on Github](#).

Conclusion

There is an almost endless list of performance optimizations that can be applied to a project. But take care to recall Donald Knuth's sage advice and not go too crazy on this. Bottlenecks will reveal themselves in production and should largely be addressed then; not in advance. There are also several third-party packages that can be helpful in identifying N+1 issues, most notably [nplusone](#), [django-zen-queries](#), and [django-auto-prefetch](#).

You should remember that performance problems are a good problem to have! They are fixable and mean that your project is being heavily used which is far better than having a completely optimized but largely ignored website.

Chapter 17: Security

The World Wide Web is a dangerous place. There are many bad actors and even more automated bots that *will* try to hack into your website and cause ill. Therefore understanding and implementing security features is a must in any website.

Fortunately, Django has a very strong record when it comes to security thanks to its years of experience handling web security issues as well as a robust and regular security update cycle.

However, as with any tool, it's important to implement security features correctly and in this chapter we'll cover how to do so in our Bookstore project.

Social Engineering

The biggest security risk to any website is ultimately not technical: it is people. The term [social engineering](#) refers to the technique of finding individuals with access to a system who will willingly or unwillingly share their login credentials with a bad actor.

These days [phishing](#) is probably the most likely culprit if you are in a technical organization. All it takes is one bad click on an email link for a malicious actor to potentially gain access to the system, or at least all the access the compromised employee has.

To mitigate this risk, implement a robust permissions scheme and only provide the exact security access an employee needs, not more. Does every engineer need access to the production database? Probably not. Do non-engineers need write access? Again, probably not. These are discussions best had up front and a good default is to only add permissions as needed, not to default to superuser status for everyone!

Django updates

Keeping your project up-to-date with the latest version of Django is another important way to stay secure. And I don't just mean being current with the [latest feature release](#) (3.2, 4.0, 4.1, etc)

which comes out roughly every 8 months. There are also monthly security patch updates that take the form of 4.0.1, 4.0.2, 4.0.3, etc.

What about **long-term support (LTS) releases**? Certain feature releases are designated as LTS and receive security and data loss fixes for a guaranteed period of time, usually around 3 years. For example, Django 3.2 LTS came out in April 2021 and will have extended support until April 2024. Django 4.2, the next LTS release, comes out in April 2023 and will have extended support until April 2026.

Can you stay on only LTS versions and not upgrade in the interim? Yes. Should you? No. It is better and far more secure to stay up-to-date with the latest version of Django if possible.

Resist the temptation and reality of many real-world projects which is not to devote a portion of developer time to staying current with Django versions. A website is like a car: it needs regular maintenance to run at its best. You are only compounding the problem if you put off updates.

How to update? Django features [deprecation warnings](#) that can and should be run for each new release by typing `python -Wa manage.py test`. It is far better to update from 3.0 to 3.1 to 3.2 and run the deprecation warnings each time rather than skipping multiple versions.

Deployment Checklist

To assist with with deployment and checking security settings, the Django docs contain a dedicated [deployment checklist](#) that further describes security settings.

Even better there is a command we can run to automate Django's recommendations, `python manage.py check --deploy`, that will check if a project is deployment ready. It uses the Django [system check framework](#) which can be used to customize similar commands in mature projects.

Since we are working in Docker we must prepend `docker-compose exec web` to the command though.

Shell

```
$ docker-compose exec web python manage.py check --deploy
System check identified some issues:
```

```
WARNINGS:
```

```
...
```

```
System check identified 6 issues (0 silenced).
```

How nice! A descriptive and lengthy list of issues which we can go through one-by-one to prepare our Bookstore project for production.

docker-compose-prod.yml

Ultimately, our local development settings will differ from our production settings. We already started to configure this back in Chapter 9: Environment Variables. Recall that we added environment variables for `SECRET_KEY`, `DEBUG`, and `DATABASES`. But we did not set production values or a way to toggle efficiently between local and production.

There are a number of ways to tackle this challenge. Our approach will be to create a dedicated `docker-compose-prod.yml` file that we can use to test the production environment locally. When it comes down to deploy our project into production, we will manually update the environment variables to match.

To start, in the base directory create a `docker-compose-prod.yml` file. It will be located right next to the existing `docker-compose.yml` file. Then *immediately* add it to our exiting `.gitignore` file. We definitely do not want our production secrets to be stored in Git and available in the source code.

.gitignore

```
.venv
__pycache__/
db.sqlite3
.DS_Store # Mac only
docker-compose-prod.yml
```

If you're curious, Github maintains an official [Python gitignore file](#) containing additional configurations worthy of further exploration.

Run `git status` again and the `docker-compose-prod.yml` file is not visible, even though it is still in our project. That's what we want!

For now, copy the contents of the `docker-compose.yml` file over into `docker-compose-prod.yml`.

docker-compose-prod.yml

```
version: '3.9'

services:
  web:
    build: .
    command: python /code/manage.py runserver 0.0.0.0:8000
    volumes:
      - ./code
    ports:
      - 8000:8000
    depends_on:
      - db
    environment:
      - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs\
4)x1"
      - "DJANGO_DEBUG=True"
  db:
    image: postgres:13
    volumes:
      - postgres_data:/var/lib/postgresql/data/
    environment:
      - "POSTGRES_HOST_AUTH_METHOD=trust"

volumes:
  postgres_data:
```

To run our new file, spin down the Docker container and restart it via the `-f` flag to specify an [alternate compose file](#). By default, Docker assumes a `docker-compose.yml` so adding the `-f` flag is unnecessary in that case.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
```

Navigate to the website and everything should run as before, even though we are using a different compose file.

DEBUG

Ultimately, our goal in this chapter is to pass Django's deployment checklist by using the `docker-compose-prod.yml` file. Let's start by changing `DEBUG`, which is set to `True`, but should be `False` in production.

docker-compose-prod.yml

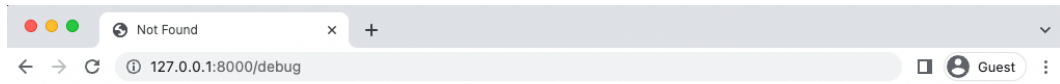
```
environment:
  - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs4)x1"
  - "DJANGO_DEBUG=False" # new
```

Spin down the Docker container and start it up again after making the change to reload the changed environment variable.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
```

The website should run the same as before, but to check that `DEBUG` is set to `False`, visit a page that doesn't exist like `http://127.0.0.1:8000/debug`.



Not Found

The requested resource was not found on this server.

Debug Page Not Found

And there is a generic “Not Found” message, confirming we have `DEBUG` set to `False`. Because if it were `True`, there would be a detailed error report instead.

Let’s run the Django deployment checklist again now that `DEBUG` has been changed. Recall that when we ran it earlier in the chapter there were 6 issues.

Shell

```
$ docker-compose exec web python manage.py check --deploy
System check identified some issues:
```

WARNINGS:

...

```
System check identified 5 issues (0 silenced).
```

We’re down to 5 since `DEBUG` is set to `False`. Progress!

Defaults

Environment variables serve two purposes in our Django project: they keep items like `SECRET_KEY` actually secret and they act as a way to toggle between local and production settings. While there is nothing wrong with having two environment variables for a setting like `DEBUG`, it is arguably cleaner to use a default value when we don’t need to keep something secret.

For example, let’s rewrite the `DEBUG` configuration to look as follows:

Code

```
# django_project/settings.py
DEBUG = env.bool("DJANGO_DEBUG", default=False) # new
```

This means default to a production value of `False` if no environment variable is present. If there is one available, `DJANGO_DEBUG`, then use that instead.

This approach of defaulting to the most secure, production-only settings is more secure because if for some reason environment variables are not loading in properly, we don't want the website to just use insecure local development variables. In other words, controls needed to be loosened to work rather than tightened. This is similar to the approach we took with our user permissions earlier in the book.

Go ahead now and update `docker-compose-prod.yml` by removing `DJANGO_DEBUG` so that only the `DJANGO_SECRET_KEY` is under the `environment` section.

docker-compose-prod.yml

```
environment:
  - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs\
4)x1"
```

If you spin down Docker again with `docker-compose down` and restart the production version the website will still work properly.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
```

SECRET_KEY

One of the five current issues that Django's deployment checklist complains about is the `SECRET_KEY`, which is randomly generated by Django each time the `startproject` command is run. It is used to provide [cryptographic signing](#) throughout your project and it is very, very important to keep secure.

Our current `SECRET_KEY` is not secure because it has been added to the Git source control multiple times. Even if we moved its current value to an environment variable now, the value will live on in our Git history forever. So a new `SECRET_KEY` must be generated and stored properly. It needs to have at least 50 characters, five or more unique characters, and not be prefixed with “django-insecure-“!

Luckily it is easy enough to generate a new random key. We can use Python’s built-in [secrets](#) module. The parameter `token_urlsafe` returns the number of bytes in a URL-safe text string. With Base64 encoding on average each byte has 1.3 characters. So using 38 results in 51 characters in this case.

Shell

```
$ docker-compose exec web python -c "import secrets; print(secrets.token_urlsafe(38))"
LHanzMtuuenbzKGXGBSHZYHXrydW3_4zBeEE7WRtZGIr00NNCbs
```

A quick reminder that since we’re working with Docker, if your `SECRET_KEY` includes a dollar sign, \$, then you need to add an additional dollar sign, \$\$\$. This is due to how `docker-compose` [handles variable substitution](#). Otherwise you will see an error!

Add the new `SECRET_KEY` to the `docker-compose-prod.yml` file so it looks as follows:

`docker-compose-prod.yml`

```
# docker-compose-prod.yml
environment:
  - "DJANGO_SECRET_KEY=LHanzMtuuenbzKGXGBSHZYHXrydW3_4zBeEE7WRtZGIr00NNCbs"
```

Because `docker-compose-prod.yml` is in our `.gitignore` file it will not appear in our source code. Restart the Docker container which now uses a truly secret `SECRET_KEY`.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
```

The website should work just as before. Run the deployment checklist again:

Shell

```
$ docker-compose exec web python manage.py check --deploy
System check identified some issues:

WARNINGS:
...
System check identified 4 issues (0 silenced).
```

We're down to 4 issues now but first a brief dive into web security so we can understand why these settings are so important.

Web Security

Even though Django handles most common security issues by default, it is still vital to understand frequent attack methods and the steps Django takes to mitigate them. You can find an overview on the [Django security page](#), but we'll go into further depth here.

Django comes by default with a number of additional [security middlewares](#) that guard against other request/response cycle attacks.

A full explanation of each is beyond the scope of this book, but it is worth reading about the protections provided by the Django security team over the years. Do not change the defaults without good cause.

SQL injection

Let's start with a [SQL injection attack](#) which occurs when a malicious user can execute arbitrary SQL code on a database. Consider a log in form on a site. What happens if a malicious user instead

types `DELETE from users WHERE user_id=user_id?` If this is run against the database without proper protections it could result in the deletion of all user records! Not good. This [XKCD comic](#) provides a humorous though potentially accurate example of how this can occur.

Fortunately the Django ORM automatically sanitizes user inputs by default when constructing queriesets to prevent this type of attack. Where you need to be careful is that Django does provide the option to execute [custom sql](#) or [raw queries](#). These should both be used with extreme caution since they could open up a vulnerability to SQL injection.

The non-profit Open Web Application Security Project (OWASP) has a fantastic and very detailed [SQL Injection Cheat Sheet](#) that is recommended for further reading.

XSS (Cross Site Scripting)

[Cross-site scripting \(XSS\)](#) is another classic attack that occurs when an attacker is able to inject small bits of code onto web pages viewed by other people. This code, typically JavaScript, if stored in the database will then be retrieved and displayed to other users.

For example, consider the form used for writing book reviews on our current site. What if instead of typing, “This book was great” a user typed something with JavaScript? For example, `<script>alert('hello');</script>`. If this script were stored on the database then every future user’s page would have a pop-up saying “hello”. While this particular example is more annoying than dangerous, a site vulnerable to XSS is very dangerous because a malicious user could insert *any JavaScript* into the page, including JavaScript that steals pretty much anything from an unsuspecting user.

To prevent an XSS attack Django templates [automatically escape](#) specific characters that are potentially dangerous including brackets (< and >), single quotes ', double quotes ", and the ampersand &. There are some edge cases where you might want to turn [autoescape off](#) but this should be used with extreme caution.

OWASP’s [XSS Cheat Sheet](#) is recommended for further reading.

Cross-Site Request Forgery (CSRF)

A [Cross-Site Request Forgery \(CSRF\)](#) is the third major type of attack but generally lesser known than SQL Injection or XSS. Fundamentally it exploits that trust a site has in a user's web browser.

When a user logs in to a website, let's call it a banking website for illustration purposes, the server sends back a session token for that user. This is included in the HTTP Headers of all future requests and authenticates the user. But what happens if a malicious actor somehow obtains access to this session token?

For example, consider a user who logs into their bank in one browser tab. Then in another tab they open their email and click on an email link from a malicious actor. This link looks legitimate, but in fact it is pointing to the user's bank which they are *still logged into!* So instead of leaving a blog comment on this fake site, behind the scenes the user's credentials are used to transfer money from their account to the hacker's account.

In practice there are multiple ways to obtain a user's credentials via a CSRF attack, not just links, but hidden forms, special image tags, and even AJAX requests.

Django provides [CSRF protection](#) by including a random secret key both as a cookie via [CSRF Middleware](#) and in a form via the `csrf_token` template tag. A 3rd party website will not have access to a user's cookies and therefore any discrepancy between the two keys causes an error.

As ever, Django does allow customization: you can disable the CSRF middleware and use the `csrf_protect()` template tag on specific views. However, undertake this step with extreme caution.

The OWASP [CSRF Cheat Sheet](#) provides a comprehensive look at the issue. Almost all major websites have been victims of CSRF attacks at some point in time.

A good rule of thumb is whenever you have a form on your site, think about whether you need to include the `csrf_token` tag in it. Most of the time you will!

Clickjacking Protection

[Clickjacking](#) is yet another attack where a malicious site tricks a user into clicking on a hidden

frame. An internal frame, known as an `iframe`, is commonly used to embed one website within another. For example, if you wanted to include a Google Map or YouTube video on your site you would include the `iframe` tag that puts that site within your own. This is very convenient.

But it has a security risk which is that a frame can be hidden from a user. Consider if a user is already logged into their Amazon account and then visits a malicious site that purports to be a picture of kittens. The user clicks on said malicious site to see more kittens, but in fact they click an `iFrame` of an Amazon item that is unknowingly purchased. This is but one example of clickjacking.

To prevent against this Django comes with a default [clickjacking middleware](#) that sets a [X-Frame-Options HTTP header](#) that indicates whether a resource is allowed to load within a frame or `iframe`. You can turn this protection off, if desired, or even set it at a per view level. However, do so with a high degree of caution and [research](#).

HTTPS/SSL

All modern websites should use [HTTPS](#), which provides encrypted communication between a client and server. [HTTP \(Hypertext Transfer Protocol\)](#) is the backbone of the modern web, but it does not, by default, have encryption.

The “s” in HTTPS refers to its encrypted nature first due to SSL (Secure Sockets Layer) and these days its successor [TLS \(Transport Layer Security\)](#). With HTTPS enabled, which we will do in our deployment chapter, malicious actors can’t sniff the incoming and outgoing traffic for data like authentication credentials or API keys.

One of the 4 remaining issues in our Django deployment checklist is that `SECURE_SSL_REDIRECT` is currently set to `False`. For security reasons, it’s far better to force this to be `True` in production. Let’s change that now. At the bottom of the `django_project/settings.py` file add a configuration for `SECURE_SSL_REDIRECT`: set it to either the environment variable `DJANGO_SECURE_SSL_REDIRECT` or the default value of `True`.

Code

```
# django_project/settings.py
SECURE_SSL_REDIRECT = env.bool("DJANGO_SECURE_SSL_REDIRECT", default=True)
```

Then we will add the environment variable to `docker-compose.yml` so that for *local* development it defaults to `False` which is the less secure setting.

docker-compose.yml

```
# docker-compose.yml
environment:
  - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs4)x1"
  - "DJANGO_DEBUG=True"
  - "DJANGO_SECURE_SSL_REDIRECT=False" # new
```

Restart Docker and run the deployment checklist again.

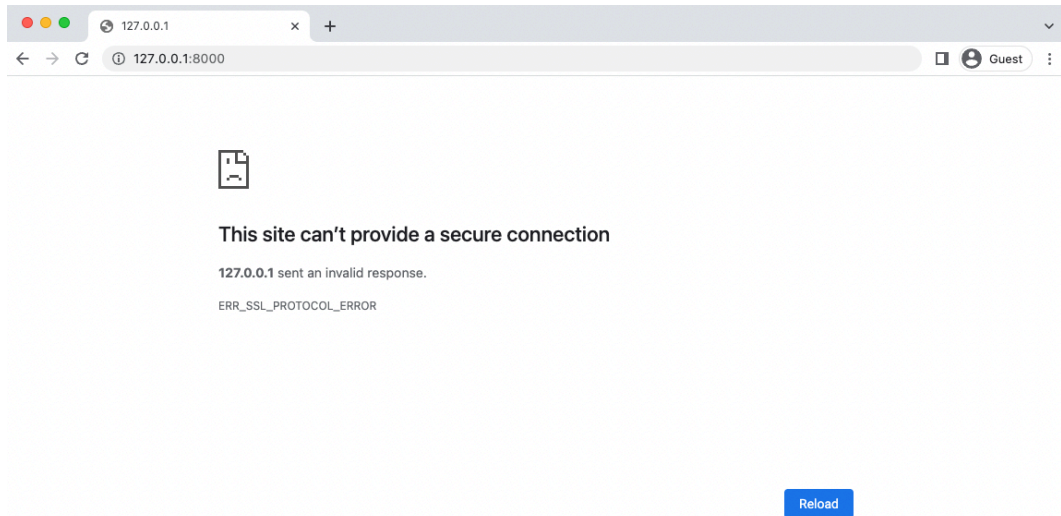
Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
$ docker-compose exec web python manage.py check --deploy
...
System check identified 3 issues (0 silenced).
```

We're down to 3 issues now.

SSL Error

If you try to visit the website now there is an issue though.



SSL Error

It seems there is some sort of SSL Protocol Error, which makes sense because we just updated an SSL setting. Where could we find more info though? How about trying the logs:

Shell

```
$ docker-compose logs
...
You're accessing the development server over HTTPS, but it only supports HTTP.
```

Ah, that's more descriptive. Since we switched the default over to True our website is automatically enforcing SLL. But the problem is that the local Django server only works over HTTP. We can run the deployment checklist to gain confidence in our production settings in `docker-compose-prod.yml` but in terms of actually using using the production site locally, we won't be able to enforce SSL.

That's ok though. It's one of many reasons why we have separate local and production configurations. Companies typically actually have **three** different environments set up: one for local, one for production, and a staging server that mimics production but allows for more actual testing before switching things over completely. The staging server is often deployed but with a hidden URL and additional permissions so only team developers can try it out.

Going forward if you want to try out the local website with production settings be aware you will have to toggle off `DJANGO_SECURE_SSL_REDIRECT`.

One more common gotcha is that even if you restart the Docker containers and start the local configuration, your web browser might still complain of an SSL error.

Shell

```
$ docker-compose down
$ docker-compose up -d
```

This is because most web browsers once they find out an HTTPS version of a site exists—even if it's a localhost like `http://127.0.0.1:8000/`—will cache that and continually revert to it. You can look up different ways to clear the cache but the most effective in this case is to restart your web browser. As ever, when something isn't working try turning it off and restarting.

HTTP Strict Transport Security (HSTS)

[HTTP Strict Transport Security \(HSTS\)](#) is a security policy that lets our server enforce that web browsers should only interact via HTTPS by adding a [Strict-Transport-Security header](#).

There are three implicit HSTS configurations in our `settings.py` file that need to be updated for production:

- `SECURE_HSTS_SECONDS = 0`
- `SECURE_HSTS_INCLUDE_SUBDOMAINS = False`
- `SECURE_HSTS_PRELOAD = False`

The `SECURE_HSTS_SECONDS` setting is set to 0 by default but the greater the better for security purposes. We will set it to the recommended 30 days, or 2,592,000 seconds, in our project.

`SECURE_HSTS_INCLUDE_SUBDOMAINS` forces subdomains to use SSL. We will set it to `True` in production.

`SECURE_HSTS_PRELOAD` only has an effect when there is a non-zero value for `SECURE_HSTS_SECONDS`, but since we just set one, we'll need to set this to `True`.

Add these three lines to the bottom of the `django_project/settings.py` file.

Code

```
# django_project/settings.py
SECURE_HSTS_SECONDS = env.int("DJANGO_SECURE_HSTS_SECONDS", default=2592000) # 30 days
SECURE_HSTS_INCLUDE_SUBDOMAINS = env.bool("DJANGO_SECURE_HSTS_INCLUDE_SUBDOMAINS",
    default=True)
SECURE_HSTS_PRELOAD = env.bool("DJANGO_SECURE_HSTS_PRELOAD", default=True)
```

Then update `docker-compose.yml` with the local development values.

docker-compose.yml

```
# docker-compose.yml
environment:
  - "DJANGO_SECRET_KEY=django-insecure-hv1(e0r@v4n4m6gqdz%dn(60o=dsy8&@0_lbs8p-v3u^bs4)x1"
  - "DJANGO_DEBUG=True"
  - "DJANGO_SECURE_SSL_REDIRECT=False"
  - "DJANGO_SECURE_HSTS_SECONDS=0" # new
  - "DJANGO_SECURE_HSTS_INCLUDE_SUBDOMAINS=False" # new
  - "DJANGO_SECURE_HSTS_PRELOAD=False" # new
```

Restart Docker and run the deployment checklist again.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
$ docker-compose exec web python manage.py check --deploy
...
System check identified 2 issues (0 silenced).
```

Only 2 issues left!

Secure Cookies

An [HTTP Cookie](#) is used to store information on a client's computer such as authentication credentials. This is necessary because the HTTP protocol is stateless by design: there's no way to tell if a user is authenticated other than including an identifier in the HTTP Header!

Django uses sessions and cookies for this, as do most websites. But cookies can and should be forced over HTTPS as well via the `SESSION_COOKIE_SECURE` config. By default Django sets this value to `False` for local development; in production it needs to be `True`.

The second issue is `CSRF_COOKIE_SECURE`, which defaults to `False` but in production should be `True` so that only cookies marked as “secure” will be sent with an HTTPS connection.

Add these two lines again to the bottom of `django_project/settings.py`.

Code

```
# django_project/settings.py
SESSION_COOKIE_SECURE = env.bool("DJANGO_SESSION_COOKIE_SECURE", default=True)
CSRF_COOKIE_SECURE = env.bool("DJANGO_CSRF_COOKIE_SECURE", default=True)
```

Then update the `docker-compose.yml` file.

docker-compose.yml

```
# docker-compose.yml
environment:
  - "DJANGO_SECRET_KEY=)*_s#exg*#w+#-xt=vu8b010%%a&p@4edwyj0=(nqq90b9a8*n"
  - "DJANGO_DEBUG=True"
  - "DJANGO_SECURE_SSL_REDIRECT=False"
  - "DJANGO_SECURE_HSTS_SECONDS=0"
  - "DJANGO_SECURE_HSTS_INCLUDE_SUBDOMAINS=False"
  - "DJANGO_SECURE_HSTS_PRELOAD=False"
  - "DJANGO_SESSION_COOKIE_SECURE=False" # new
  - "DJANGO_CSRF_COOKIE_SECURE=False" # new
```

Restart Docker and run the deployment checklist again.

Shell

```
$ docker-compose down
$ docker-compose -f docker-compose-prod.yml up -d
$ docker-compose exec web python manage.py check --deploy
System check identified no issues (0 silenced).
```

No more issues. Woohoo!

Admin Hardening

So far it may seem as though the general security advice is to rely on Django defaults, use HTTPS, add `csrf_token` tags on forms, and set a permissions structure. All true. But one additional step Django does not take on our behalf is hardening the Django admin.

Consider that every Django website sets the admin, by default, to the `/admin` URL. This is a prime suspect for any hacker trying to access a Django site. Therefore, an easy step is to simply change the admin URL to literally anything else! Open up and change the URL path. In this example it is `anything-but-admin/`.

Code

```
# django_project/urls.py
from django.conf import settings
from django.conf.urls.static import static
from django.contrib import admin
from django.urls import path, include

urlpatterns = [
    # Django admin
    path("anything-but-admin/", admin.site.urls), # new
    # User management
    path("accounts/", include("allauth.urls")),
    # Local apps
    path("", include("pages.urls")),
    path("books/", include("books.urls")),
]

if settings.DEBUG:
    import debug_toolbar

    urlpatterns = [
        path("__debug__/", include(debug_toolbar.urls)),
    ] + urlpatterns
```

A fun 3rd party package [django-admin-honeypot](#) will generate a fake admin log in screen and email [site admins](#) the IP address of anyone trying to attack your site at `/admin`. These IP addresses can then be added to a blocked address list for the site.

It's also possible via [django-two-factor-auth](#) to add two-factor authentication to your admin for an even further layer of protection.

Git

This chapter has been particularly heavy on code changes so make sure to commit all the updates with Git.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch17'
```

If you have any errors, check your logs with `docker-compose logs` and compare your code with the [official source code on Github](#).

Conclusion

Security is a major concern for any website. By using a `docker-compose-prod.yml` file we can accurately test, within Docker, our production settings *before* deploying the site live. And by using default values we can both simplify the environment variables in the file as well as ensure that if something goes awry with environment variables we will default to secure production values. Django comes with many built-in security features and with the addition of the deployment checklist we can now deploy our site now with a high degree of confidence that it is secure.

Ultimately, security is a constant battle and while the steps in this chapter cover most areas of concern, keeping your website up-to-date with the latest Django version is vital for continued safety.

Chapter 18: Deployment

So far we have been working entirely in a local development environment on our computer. But now it is time to deploy our project so that it is accessible to the public. In truth, the topic of deployment is worth an entire book on its own. Compared to other web frameworks Django is very hands-off and agnostic on the topic. There are no one-click deploys for most hosting platforms and while this requires more developer work it also allows, in typical Django fashion, for a high degree of customization.

In the previous chapter we configured a completely separate `docker-compose-prod.yml` file and updated `django_project/settings.py` to be production-ready. In this chapter we'll review how to choose a hosting provider, add a production-ready web server, and properly configure static/media files before deploying our Bookstore site!

PaaS vs IaaS

The first question is whether to use a Platform-as-a-Service (PaaS) or Infrastructure-as-a-Service (IaaS). A PaaS is an opinionated hosting option that handles much of the initial configuration and scaling needed for a website. Popular examples include [Heroku](#), [PythonAnywhere](#), and [Dokku](#) among many others. While a PaaS costs more money upfront than an IaaS it saves an incredible amount of developer time, handles security updates automatically, and can be quickly scaled.

An IaaS by contrast provides total flexibility and is typically cheaper, but it requires a high degree of knowledge and effort to properly set up. Prominent IaaS options include [DigitalOcean](#), [Linode](#), [Amazon EC2](#), and [Google Compute Engine](#) among many others.

So which one to use? Django developers tend to fall in one of two camps: either they already have a deployment pipeline configured with their IaaS of choice or they use a PaaS. Since the former is far more complex and varies widely in its configuration, we will use a PaaS in this book, specifically Heroku.

The choice of Heroku is somewhat arbitrary, but it is a mature technology that comes with a truly free tier sufficient for deploying our Bookstore project.

WhiteNoise

We have already seen that for local development Django relies on the `staticfiles` app to serve static files from across an entire project. This is convenient, but quite inefficient and likely insecure, too.

For production, the `collectstatic` command must be run to compile all static files into a single directory specified by `STATIC_ROOT`. The consolidated files can then be served either on the same server, a separate server, or a dedicated cloud service/CDN by updating `STATICFILES_STORAGE`.

In our project, we will rely on serving files from our server with the aid of the `WhiteNoise` project which works extremely well on Heroku and is both faster and more configurable than Django defaults. To install `whitenoise` we will add it to our `requirements.txt` file, stop the container, rebuild the image, and start the server again.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycpg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
environs[django]==9.5.0
pillow==9.0.1
django-debug-toolbar==3.4.0
whitenoise==6.1.0
```

Then stop our Docker container.

Shell

```
$ docker-compose down
```

We won't rebuild the image and restart the container just yet because we also have to make changes to our `django_project/settings.py` file first. Since we're using Docker it's possible to switch to WhiteNoise locally as well as in production. While it's possible to do this by passing in a `--nostatic` flag to the `runserver` command, this becomes tiring in practice. A better approach is to add `whitenoise.runserver_nostatic` before `django.contrib.staticfiles` in the `INSTALLED_APPS` config which will do the same thing. We'll also add it to our `MIDDLEWARE` right below `SecurityMiddleware` and update `STATICFILES_STORAGE` to use WhiteNoise now.

Code

```
# django_project/settings.py
INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "whitenoise.runserver_nostatic", # new
    "django.contrib.staticfiles",
    "django.contrib.sites",
    ...
]

MIDDLEWARE = [
    "django.middleware.cache.UpdateCacheMiddleware",
    "django.middleware.security.SecurityMiddleware",
    "whitenoise.middleware.WhiteNoiseMiddleware", # new
    ...
]

STATICFILES_STORAGE =
    "whitenoise.storage.CompressedManifestStaticFilesStorage" # new
```

Note that `STATICFILES_STORAGE` should be one line. It is formatted on two lines here to fit the book format.

With all our changes made we can now start up our project again in local development mode.

Shell

```
$ docker-compose up -d --build
```

WhiteNoise has additional options to serve compressed content and far-future cache headers on content that won't change. But for now, go ahead and run the `collectstatic` command. There will be a warning about overwriting existing files. That's fine. Type “yes” and then hit the “Return” key to continue.

Shell

```
$ docker-compose exec web python manage.py collectstatic
...
140 static files copied to '/code/staticfiles', 2 unmodified, 404 post-processed.
```

Media Files

Media files such as the book covers in our site are unfortunately a little more complicated than static files for reasons covered in Chapter 13. As a result, while they will appear as desired in local development, they will not remain long in a production setting. The recommended approach is to use the very popular [django-storages](#) package alongside a dedicated CDN like S3. However this requires additional configuration that is beyond the scope of this book.

Gunicorn

When we ran the `startproject` command way back in Chapter 3, a `django_project/wsgi.py` file was created with a default [WSGI \(Web Server Gateway Interface\)](#) configuration. This is a specification for how a web app (like our Bookstore project) communicates with a web server.

For production it is common to swap this out for either [Gunicorn](#) or [uWSGI](#). Both offer a performance boost, but Gunicorn is more focused and simpler to implement so it will be our choice.

First add it to the bottom of the `requirements.txt` file.

requirements.txt

```
asgiref==3.5.2
Django==4.0.4
psycopg2-binary==2.9.3
sqlparse==0.4.2
django-crispy-forms==1.14.0
crispy-bootstrap5==0.6
django-allauth==0.50.0
environs[django]==9.5.0
pillow==9.0.1
django-debug-toolbar==3.4.0
whitenoise==6.1.0
gunicorn==20.1.0
```

Because we are using Docker our local environment can mimic production quite easily so we'll update both `docker-compose.yml` and `docker-compose-prod.yml` to use Gunicorn instead of the local server.

docker-compose.yml

```
# command: python /code/manage.py runserver 0.0.0.0:8000
command: gunicorn django_project.wsgi -b 0.0.0.0:8000 # new
```

docker-compose-prod.yml

```
# command: python /code/manage.py runserver 0.0.0.0:8000
command: gunicorn django_project.wsgi -b 0.0.0.0:8000 # new
```

Then spin down our container, rebuild a new image, and restart the container.

Shell

```
$ docker-compose down
$ docker-compose up -d --build
```

Heroku

Head over to the [Heroku](#) website and sign up for a free account. After you confirm your email Heroku will redirect you to the dashboard section of the site.

Next make sure to install Heroku's *Command Line Interface (CLI)* so we can deploy from the command line. There are detailed [instructions here](#).

The final step is to log in with your Heroku credentials via the command line by typing `heroku login`. Use the email and password for Heroku you just set.

Shell

```
$ heroku login
Opening browser to https://cli-auth.heroku.com/auth/cli/browser/...
Logging in... done
Logged in as will@wsvincent.com
```

All set! If you have any issues you can type `heroku help` on the command line or visit the Heroku site for additional information.

Deploying with Docker

Since we are using Docker containers locally we might as well do the same in production. Traditional non-Docker Heroku relies on a custom `Procfile` for configuring a site for deployment. For containers Heroku relies on a similar approach but it is called a [heroku.yml](#) file.

In your text editor create a `heroku.yml` file now in the base directory. There are four [top-level sections](#) available for configuration: `setup`, `build`, `release`, and `run`.

The main function of `setup` is to specify which add-ons are needed. These are hosted solutions Heroku provides, typically for a fee. The big one is our database which will rely on the free [heroku-postgresql](#) tier. Heroku takes care of provisioning it, security updates, and we can easily upgrade the database size and uptime as needed.

The `build` section is where we specify how the `Dockerfile` should be built. This relies on our current `Dockerfile` in the root directory. The `release` phase is used to run tasks before each new release is deployed. For example, we can make sure `collectstatic` is run on every deploy automatically. Finally there is the `run` phase where we specify which processes actually run the application. Notably, the use of `Gunicorn` as the web server.

heroku.yml

```
setup:
  addons:
    - plan: heroku-postgresql
build:
  docker:
    web: Dockerfile
release:
  image: web
  command:
    - python manage.py collectstatic --noinput
run:
  web: gunicorn django_project.wsgi
```

Make sure to add the new deployment updates to Git and commit them. In the next section we'll push all our local code to Heroku itself.

Shell

```
$ git status
$ git add .
$ git commit -m 'ch18'
```

Heroku Deployment

Now create a new app on Heroku for our Bookstore project. If you type `heroku create` it will assign a random name. Since names are global in Heroku, it's unlikely that common ones like “blog” or “webapp” will be available. The name can always be changed later within the Heroku website dashboard to an available global namespace.

Shell

```
$ heroku create
Creating app... done, â€¢ mysterious-hollows-62532
https://mysterious-hollows-62532.herokuapp.com/ |
https://git.heroku.com/mysterious-hollows-62532.git
```

In this case Heroku assigned my app the name `mysterious-hollows-62532`. If you refresh the Heroku dashboard on the website you will now see the newly created app. Click on the new app to open the “Overview” page.

The screenshot shows the Heroku dashboard for the app 'mysterious-hollows-62532'. The browser address bar shows 'dashboard.heroku.com/apps/mysterious-hollows-62532'. The page header includes the Heroku logo, a search bar, and a user profile. The main navigation bar has tabs for Overview, Resources, Deploy, Metrics, Activity, Access, and Settings. The Overview tab is selected. Below the navigation bar, there's a section for 'Personal' and 'mysterious-hollows-62532' with 'Open app' and 'More' buttons. The main content area is divided into several sections: 'Installed add-ons' (showing \$0.00/month and a message that there are no add-ons), 'Dyno formation' (showing \$0.00/month and a message that the app has no process types yet), 'Collaborator activity' (showing no recent activity), and 'Latest activity' (showing two events: 'Enable Logplex' and 'Initial release').

Heroku Overview Page

The next step is to add our production environment variables from `docker-compose-prod.yml`. Click on the “Settings” option at the top of the page and then click on “Reveal Config Vars.”

Because we are using default values so liberally in `django_project/settings.py`, there is only one value to set in production: `DJANGO_SECRET_KEY`.

The screenshot shows the Heroku dashboard for the application 'mysterious-hollows-62532'. The 'Settings' tab is selected, displaying 'App Information' and 'Config Vars'.

App Information

App Name	mysterious-hollows-62532
Region	United States
Stack	heroku-20
Framework	No framework detected
Slug size	No slug detected
Heroku git URL	https://git.heroku.com/mysterious-hollows-62532.git

Config Vars

Config vars change the way your app behaves. In addition to creating your own, some add-ons come with their own.

KEY	VALUE	
DJANGO_SECRET_KEY	LHanzMtuenbzKGXGBSHZYHXrydw	
KEY	VALUE	

Heroku Config Vars

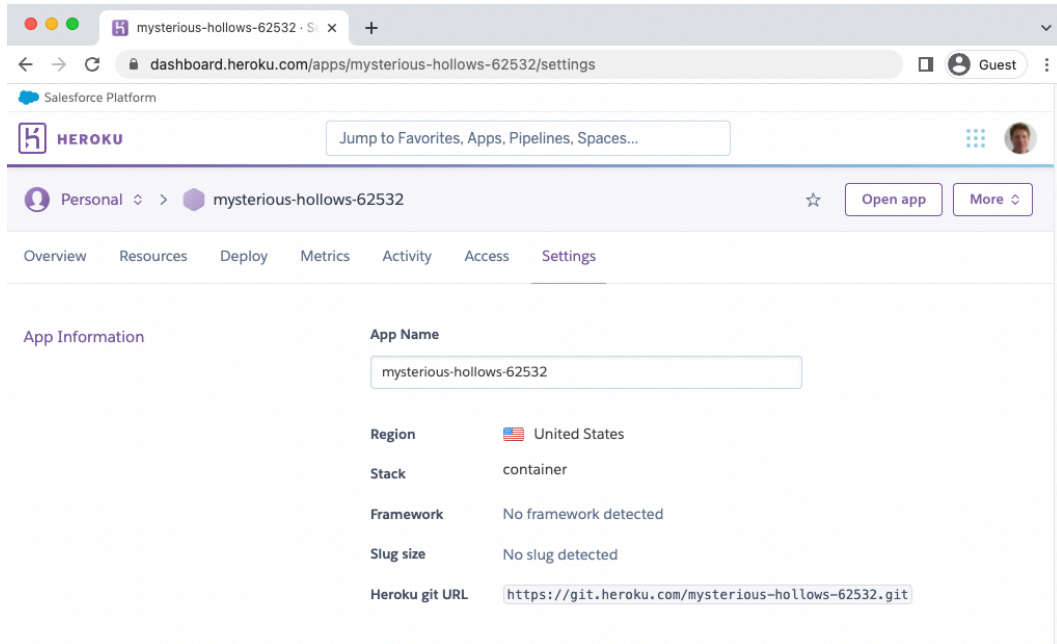
Now set the `stack` to use our Docker containers, not Heroku's default buildpack. Include your app name here at the end of the command after `heroku stack:set container -a`.

Shell

```
$ heroku stack:set container -a mysterious-hollows-62532
Setting stack to container... done
```

To confirm this change executed correctly, refresh the Heroku dashboard web page and note that at the top of the Settings page, under "App Information", the "Stack" is now set to "container."

That's what we want.



Heroku Stack

Before pushing our code to Heroku we must specify the hosted PostgreSQL database we want. In our case, the free hobby-dev tier works well; it can always be updated in the future.

Shell

```
$ heroku addons:create heroku-postgresql:hobby-dev -a mysterious-hollows-62532
Creating heroku-postgresql:hobby-dev on â€¢ mysterious-hollows-62532... free
Database has been created and is available
! This database is empty. If upgrading, you can transfer
! data from another database with pg:copy
Created postgresql-vertical-87783 as DATABASE_URL
Use heroku addons:docs heroku-postgresql to view documentation
```

Did you notice how the DATABASE_URL variable was automatically created there! That's why we did not have to set it as a production environment variable. Pretty cool.

ALLOWED_HOSTS

Now that we know the dedicated URL of our production website we can add it to our `django_project/settings.py` file. Update the existing entry for `ALLOWED_HOSTS` as follows:

Code

```
# django_project/settings.py
ALLOWED_HOSTS = ["mysterious-hollows-62532.herokuapp.com", "localhost", "127.0.0.1"] # n\
ew
```

Then create a new Git commit to reflect the change.

Shell

```
$ git status
$ git commit -m 'updated ALLOWED_HOSTS setting'
```

Doing It Live!

Ok, we're ready! Create a [Heroku remote](#), which means a version of our code that will live on a Heroku-hosted server. Make sure to include `-a` and the name of your app. Then “push” the code to Heroku which will result in building our Docker image and running the containers.

Shell

```
$ heroku git:remote -a mysterious-hollows-62532
set git remote heroku to https://git.heroku.com/mysterious-hollows-62532.git
$ git push heroku main
...
remote: Waiting for release.... done.
To https://git.heroku.com/mysterious-hollows-62532.git
 * [new branch]      main -> main
```

The initial push might take a while to complete. You can see active progress by clicking on the “Activity” tab on the Heroku dashboard.

myerious-hollows-62532 · A x +

← → ↻ dashboard.heroku.com/apps/mysterious-hollows-62532/activity

Salesforce Platform

HEROKU Jump to Favorites, Apps, Pipelines, Spaces...

Personal > mysterious-hollows-62532 ☆ Open app More

Overview Resources Deploy Metrics Activity Access Settings

If you use GitHub, you can link your deploys to the code diff on GitHub. Hide Connect to GitHub

Activity Feed

- will@wsvincent.com: Build in progress
Just now · [View build progress](#)
- will@wsvincent.com: @ref:postgresql-vertical-87783 completed provisioning, setting DATABASE_URL
Today at 5:58 PM · v6
- will@wsvincent.com: Attach DATABASE (@ref:postgresql-vertical-87783)
Today at 5:58 PM · v5 · [Roll back to here](#)
- will@wsvincent.com: Upgrade stack to container
Today at 5:56 PM · v4 · [Roll back to here](#)
- will@wsvincent.com: Set DJANGO_SECRET_KEY config var
Today at 5:55 PM · v3 · [Roll back to here](#)
- will@wsvincent.com: Enable Logplex
Today at 5:48 PM · v2 · [Roll back to here](#)
- will@wsvincent.com: Initial release
Today at 5:48 PM · v1 · [Roll back to here](#)

Heroku Activity

Our Bookstore project should now be available online. Remember that while the code mirrors our own local code, the production site has its own database that has no information in it. To run commands on it add `heroku run` to standard commands. For example, we should migrate our initial database and then create a superuser account.

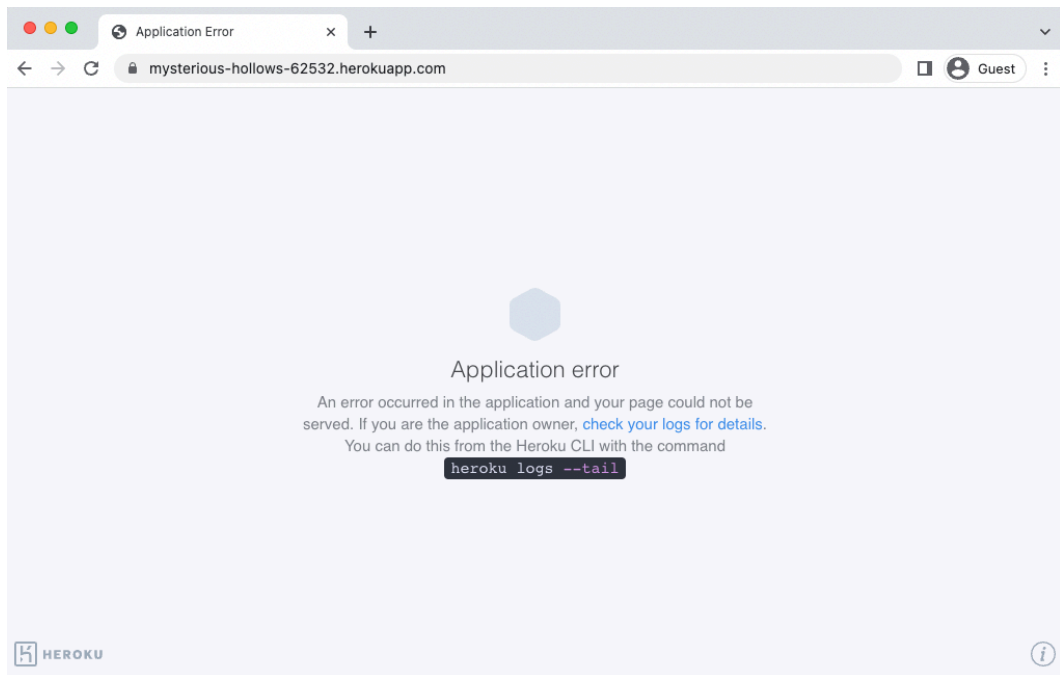
Shell

```
$ heroku run python manage.py migrate
$ heroku run python manage.py createsuperuser
```

There are two ways to open the newly-deployed application. From the command line you can type `heroku open -a` and the name of your app. Or you can click on the “Open app” button in the upper right corner of the Heroku dashboard.

Shell

```
$ heroku open -a mysterious-hollows-62532
```

**Heroku Redirects**

But...ack! What's this? A redirect error. Welcome to the joys of deployment where issues like this will crop up all the time.

SECURE_PROXY_SSL_HEADER

Some sleuthing uncovers that the issue is related to our `SECURE_SSL_REDIRECT` setting. Heroku uses proxies and so we must find the proper header and update `SECURE_PROXY_SSL_HEADER` accordingly.

By default it is set to `None`, but since we *do* trust Heroku we can update it to `('HTTP_X_FORWARDED_PROTO', 'https')`. This setting won't harm us for local development so we'll add it directly into the `django_project/settings.py` file as follows:

Code

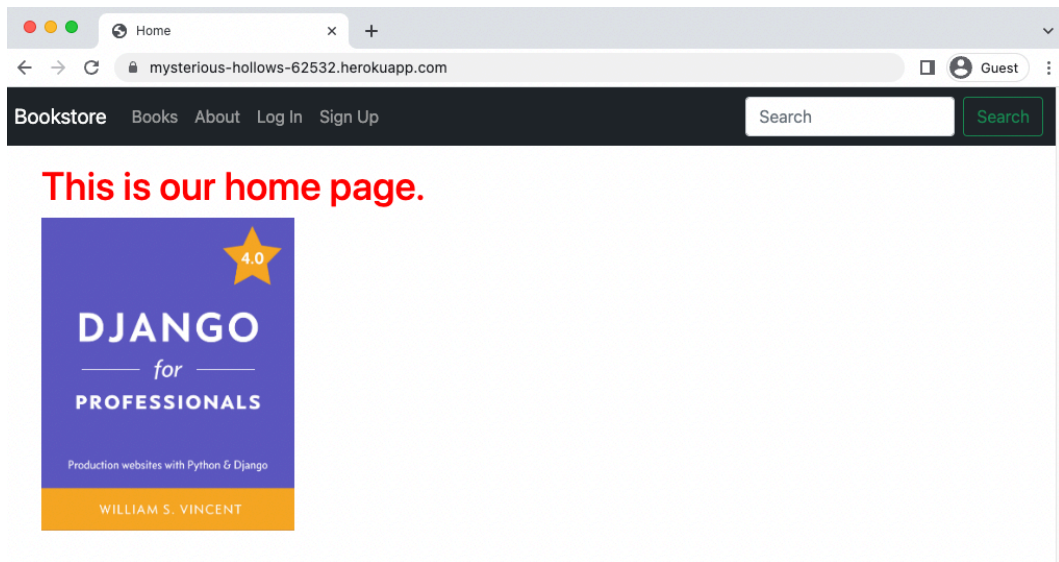
```
# django_project/settings.py
SECURE_PROXY_SSL_HEADER = ("HTTP_X_FORWARDED_PROTO", "https") # new
```

Commit these change to Git and push the updated code to Heroku.

Shell

```
$ git status
$ git commit -m 'secure_proxy_ssl_header and allowed_hosts update'
$ git push heroku main
```

After the build has completed refresh the webpage for your site. There it is!



Heroku Live Site

Production Database

New web developers often wonder why our new live site doesn't mimic what we have locally. Where are the books? And reviews?

This is because our local database and production database are completely different things. The live site doesn't know anything about the local Docker container containing our PostgreSQL database and the information we've added. To mimic what we have locally you need to log into the admin section of your live production site. Then add any users, books, reviews, and so on that you want.

Remember that `django-storages` needs to be configured if you want book covers, which are media files, to remain for an extended period of time.

Heroku Logs

It is inevitable that you will have errors in your deployment at some point. When you do, run `heroku logs` to see error and info logs and debug what's going on.

Hopefully this deployment process was smooth. But in practice, even with an established Platform-as-a-Service like Heroku, it is highly likely that issues will occur. If you see an error page, type `heroku logs --tail`, which displays info and error logs, to diagnose the issue.

Heroku comes with a large list of [add-on services](#) that, for a fee, can be quickly added to any site. If you're using a custom domain for your site, ensuring SSL is vital for any website. You will need to [be on a paid tier on Heroku](#) to enable this functionality.

Conclusion

There was a lot of code in this chapter so if you have any errors, please check the [official source code on Github](#).

Even with all the advantages of a modern Platform-as-a-Service like Heroku, deployment remains a complicated and often frustrating task for many developers. Personally, I want my web apps to “just work”. But many engineers come to enjoy the challenges of working on performance, security, and scaling. After all, it is far easier to measure improvements in this realm: did page load times decrease? Did site uptime improve? Is security up-to-date? Working on these problems can often feel far more rewarding than debating which new feature to add to the site itself.

Conclusion

Building a “professional” website is no small task even with all the help that a batteries-included web framework like Django provides. Docker provides a major advantage in standardizing both local and production environments regardless of local machine—and especially in a team context. However Docker is a complicated beast on its own. While we have used it judiciously in this book there is much more that it can do depending on the needs of a project.

Django itself is friendly to small projects because its defaults emphasize rapid local development but these settings must be systematically updated for production, from upgrading the database to PostgreSQL, using a custom user model, environment variables, configuring user registration flow, static assets, email... on and on it goes.

The good news is that the steps needed for a production-level approach are quite similar. Hence the first half of this book is deliberately agnostic about the eventual project that is built: you'll find these steps are standard on almost any new Django project. The second half focused on building a real Bookstore site with modern best practices, added Reviews, image uploads, set permissions, added search, reviewed performance and security measures, and finally deployed on Heroku with containers.

For all the content covered in this book we've really only scratched the surface of what Django can do. This is the nature of modern web development: constant iteration.

Django is a magnificent partner in building out a professional website because so many of the considerations required have already been thought of and included. But knowledge is needed to know how to turn these production switches on to take full advantage of the customization Django allows. Ultimately that is the goal of this book: to expose you, the reader, to the full spectrum of what Django and professional websites require.

As you learn more about web development and Django I'd urge caution when it comes to premature optimization. It is always tempting to add features and optimizations to your project that you *think* you'll need later. The short list includes adding a CDN for static and media assets, judiciously analyzing database queries, adding indexes to models, and so on.

The truth is that in any given web project there will always be more to do than time allows. This book has covered the fundamentals that are worthy of upfront time to get right. Additional steps around security, performance, and features will present themselves to you in real-time. Try to resist the urge to add complexity until absolutely necessary.

Learning Resources

As you become more comfortable with Django and web development in general, you'll find the [official Django documentation](#) and [source code](#) increasingly valuable. I refer to both on an almost daily basis.

The [official Django forum](#) is a great resource albeit underutilized resource for Django-specific questions. Many knowledgeable Django developers are on there and willing to help.

If you like podcasts, I have co-hosted the [Django Chat](#) podcast alongside Django Fellow Carlton Gibson for the past three years. We release episodes every other week featuring prominent guests from the Django community. And I co-author a weekly newsletter, [Django News](#), filled with the latest news, articles, tutorials, and projects focused on Django.

Feedback

As a final note, I'd love to hear your thoughts about the book. It is a constant work-in-progress and the detailed feedback from readers helps me continue to improve it. I respond to every email and can be reached at will@wsvincent.com.

If you purchased this book on Amazon, please consider leaving an honest review. These reviews make an enormous impact on book sales.

Thank you for reading the book and good luck on your journey with Django!